METAL INDUSTRY

3 JANUARY 1958

Market Development

A MAJOR problem in the non-ferrous metal industry is that market development activity has not kept pace with the vast increases which have occurred in production potential. This problem has been further aggravated by the inroads made in the potential market for metals by non-metallic materials. In order to stimulate aggressive, imaginative market development in the United States metal-working industry, our contemporary, *American Metal Market*, has created marketing awards in each of three categories: steel, stainless steel and nickel; copper, lead, and zinc; aluminium, magnesium, and titanium. Two criteria were used by the independent committee of three marketing experts in assessing the entries. The first criterion was the development of a metal to replace a non-metal in a consumer or industrial end-use product application. This criterion is based on the belief that the potential over-supply in the metal industry will not be overcome by excessive competition between metal users within the industry. The second criterion was based on the total market expansion made possible because of better products at lower prices through technological and market developments. Such advancements are usually not as spectacular nor as tangible as the development of new uses for a product, nor can the contribution of a single fabricator or producer be easily pinpointed.

Examples of the diversity of the new products which earned awards include an aluminium light-diffusion material developed as an entirely new application of their basic product by a company whose principal product was an aluminium sandwich structure for aircraft applications. Initial marketing attempts being greeted with considerable resistance, an extensive programme of direct market stimulation was undertaken, including working with architects to show them the advantages of the product. In fact, the ultimate success of the product may be said to have hinged on the marketing effort which was made. Another case is that of a company who received an award for their innovation in combining metals with plastics and fibres to develop metallic yarns. In the light metal category again an award was made for the marketing effort undertaken to gain consumer acceptance of aluminium boats. That this has been a success is evidenced by the fact that although the aluminium boats cost slightly more than wooden ones the numbers of each type sold annually are about equal. In the steel category an award was made for the extensive market development undertaken to introduce wrought iron tie spacers for railway applications. Numerous obstacles were encountered in introducing this product in place of wooden timbers and aggressive marketing was required to overcome prejudices in this conservative market.

Of a more general nature are the efforts of the Chase Copper and Brass Company who in the past five years have spent over $2 million to stimulate consumer demand for merchandise made of brass and copper. Results directly attributable to the campaign have been outstanding. Articles previously made of wood, glass, plastics, ceramics and other non-metallic materials are now being made of copper and brass, and new markets are already being developed for these metals. In the same category come the significant educational and developmental functions which the New Jersey Zinc Company has undertaken in promoting wider and improved applications of the die-casting process. The company's activities in the interests of users of die-castings have also been notable, particularly the publicizing of new uses to encourage further diversification. In both these instances the awards state that a significant part of these companies' contributions has been in the benefits which have accrued to the entire non-ferrous metal industry.

Out of the MELTING POT

Contrary

BECAUSE of their crystal structure, magnesium and magnesium-base alloys are well known to present certain limitations to cold working by rolling and other means. Frequent annealing or a resort to hot working are commonly used to avoid these limitations. In view of this, it is all the more surprising to learn of certain magnesium alloys which have recently been discovered to have unlimited cold-rollability and actually to "soften" with progressive cold rolling. This effect is observed in binary alloys with small amounts of calcium, zirconium, thorium or rare earths, and ternary and more complex alloys containing combinations of these elements with or without manganese. The effect requires a large ratio of roll diameter to starting gauge (about 50:1) and a small reduction per pass (about 2 per cent). Under these conditions, the proof stress in tension is found to show a moderate increase up to about 15 per cent reduction. This is followed by a continuous decrease with greater reductions. In many cases, the proof stress after a large total reduction is less than that of the annealed starting material. Microscopic examination of the cold-rolled alloys in polarized light showed that this anomalous behaviour is associated with the formation (apparently by a double twinning mechanism) of bands. This involves the reorientation of discrete volumes of metal to a position where the operation of basal slip within them is very favourable. These bands also act as "soft" regions during a tensile test, and since their numbers increase with increasing reductions, the measured tensile strength decreases. The alloys "softened" in this way by cold rolling, age harden on being heated to a moderate temperature (e.g. 1 hr. at 400°F.); there occurs an increase in proof stress which is greater the greater the previous cold reduction. This behaviour is again connected with the bands which are formed during cold rolling. These harden on ageing, possibly because of polygonization followed by solute atom pinning of dislocation walls.

Paper-wrapped

MUCH ink has been spread over paper in dealing with the problems created by the uncontrolled growth of the surface area of paper spread over with writing. Less attention has been given to various human problems to which this growth of reading matter—for that is what printed matter, unless consigned directly to library shelves, files, or waste paper basket, really is—has given rise. Indeed, so small has been this attention that mention of it runs the risk of being countered by the query:—What problems? Indeed, such has been the neglect, and very often the misunderstanding, of these problems that one has the occasion of meeting regrets expressed over the time lost to reading as a result of, for example, TV, and attempts to cram even more reading into a given time by training in improved reading habits, which attempts, incidentally, are unlikely to be continued since it appears that the effects of such training, at least in the case of grown-ups with firmly established reading habits, are only temporary. Thus, those human problems in question have either been misunderstood and, therefore, tackled from the wrong end, or have become completely papered over and, in consequence, been neglected. Among the latter problems is that of communication by word of mouth. As one of the earliest, and still the most effective, methods of communication—the printed word and electronic channels of communication notwithstanding—its effectiveness is, alas, only too often diminished by the introduction at some stage or other of paper. Thus, after a number of people have gone to the trouble of getting together under conditions expressly intended for verbal communication, the meeting is made the occasion of *reading* a *Paper*. How often is a discussion wound up by the promise of putting the various points raised on paper? How often is verbal communication eschewed in favour of writing yet another interdepartmental memo? Admittedly, the written word has the advantage of permanence with the ability long to outlive its usefulness, and the advantage of providing an opportunity of repeated future reference if on such occasions in the future the particular bit of paper bearing it can be located.

Bubbly

NO, sorry, that is not the subject. In producing hot-dip coatings of aluminium on surfaces of iron or steel, the usual purpose is to provide such surfaces with protection against rusting on exposure to the atmosphere or against scaling on heating in air. When it comes to providing bearing surfaces, the method generally preferred is that of roll bonding suitably prepared surfaces of pre-heated strips of aluminium-base bearing alloy and steel. In the circumstances, it is probably worth noting the existence of at least one method in which hot dip coating with aluminium is used to produce a bearing surface layer on a ferrous metal, especially as the layer finally obtained has the added feature of porosity which gives it oil-holding characteristics. The method involves the dipping of the steel in a bath of molten aluminium which has been encouraged to absorb gas by being held at 1,400-1,500°F., while additional gas may be introduced by dipping the steel at a temperature of 1,400-1,600°F. or higher directly from a bright annealing furnace. The immersion lasts for about 5 min., being sufficient to produce a coating of 2 to 7 mils thick. The aluminium-coated steel is then subjected to rapid heating to a temperature of about 1,800°F., for a period of time between 35 min. and 2 hr. The desired effect of this heat-treatment, which is critical particularly as to temperature, which should not be less than 1,700°F., is an interdiffusion of the iron and aluminium with the formation of an iron-aluminium alloy, and the liberation of gas dissolved in the aluminium in the form of minute bubbles. If the temperature is not high enough, this gas is trapped as a layer or line of minute bubbles adjacent to the iron-aluminium bonding layer, and a weak, brittle structure results in this zone. If the heating is adequate, the bubbles tend to disperse uniformly through the outer layers to form the desired porous structure in the outer surface of the alloy, at the same time leaving the alloy bond between the steel and the aluminium formed at the time of coating substantially free from porosity. The surface may be finished by grinding and polishing, which will expose some of the minute pores and produce a uniformly discontinuous surface, the oil-absorbing and holding properties of which make it particularly suitable for use under conditions of intermittent lubrication.

Skimmer

PROPERTIES AND APPLICATIONS OF ALUMINOUS CEMENT IN METALLURGICAL WORK

Castable Refractories

By A. E. WILLIAMS, Ph.D.

ALUMINOUS cement has long been known to the civil engineer, the architect and the builder as a material which enables concrete made with it to be put into service at the end of 24 hr. after placing. This unique property of rapid hardening is still maintained when the aluminous cement is used in admixture with refractory aggregates to produce refractory concretes and mortars. Since aluminous cement can also withstand elevated temperatures, it naturally becomes a valuable bonding material for the rapid production of castable refractories. In the past decade much experimental work has been done on the behaviour of refractory materials of this type, particularly with regard to strength and heat-resistance of the finished product. Aluminous cement, or high-alumina cement, is available in different parts of the world under various proprietary names, such as "Ciment Fondu" (British and French), "Lightning" (British), "Rolandshütte" (German), and "Lumnite" (American).

The composition of these cements differs from Portland cement in that they consist essentially of calcium aluminate, as opposed to the calcium silicate of Portland cement. From the practical viewpoint, this difference in composition bestows on the aluminous cement a normal setting time followed by rapid hardening, a high resistance to chemical attack and to elevated temperatures, which latter property makes it suitable for use as a bond for refractory aggregates. More recently, a high-purity calcium aluminate cement, "Secar," has become available, and is particularly applicable to the production of special duty refractory concretes and mortars to withstand temperatures up to 1,800°C. This material is a little more expensive than the ordinary types of aluminous cement, so that its use is normally confined to applications involving service temperatures between 1,200°C. and 1,800°C., lower temperature duties being served equally well by the use of ordinary aluminous cement.

Properties

Since refractory concrete consists essentially of a mixture of aluminous cement with refractory aggregates, the properties of the final product will vary with the type of aggregate used, its particle size, mixing and placing techniques. While the quality of the concrete can be varied considerably by such factors, the properties of the cement itself can be regarded as a standard. This standard is relatively high because the cement contains no free lime and is entirely stable up to its melting point. It is well known that Portland cements are unsuitable for elevated temperature work, due to the fact that even at moderate temperatures they are chemically decomposed and disintegrate owing to the presence of free lime. The latter does not exist in aluminous cement to make it vulnerable to heat or chemical action.

A typical refractory concrete is one made up of aluminous cement and crushed alumino-silica firebrick in the proportions, by volume, of 1 part cement to 2½-5 parts firebrick, depending on the thickness and application of the concrete; particle size also being governed by these factors. Under normal service conditions, such concrete is capable of withstanding temperatures up to 1,350°C. Where a higher temperature resistance or slag resistance is required, aggregates such as chrome, sillimanite, corundum, etc., may be employed.

The effect of temperature on the strengths of concrete made with different cement contents may be seen from the curves in Fig. 1, which report work done by Heindl and Post.[1] A study of these curves shows that the cold strength is partially lost as the temperature increases, due to the gradual elimination of the hydraulic bond of the cement. Before this can occur completely, however, a ceramic bond is formed, which increases both with time and temperature such that, at the higher temperatures, a fired strength is obtainable which may well be superior to the high cold strength. These curves show that with furnaces, for example, operating at relatively low temperatures, in the region of 600°C. to 1,000°C., and where the prime considerations are strength and abrasion resistance, it is advantageous to employ a concrete with a cement content greater than that in the normally recommended mixes; although it should not be overlooked that the service temperature limit of a concrete tends to decrease with greater cement contents.

The refractoriness of different mixtures has been studied in the laboratories of Lafarge Aluminous Cement Co. Ltd., using Ciment Fondu with a firebrick aggregate of 36 per cent alumina content, and the following figures have been obtained:—5 per cent cement=1,680°C., 10 per cent cement=1,620°C., 15 per cent cement =1,595°C., 20 per cent cement =1,490°C., 25 per cent cement =1,450°C., and 40 per cent cement=1,350°C. Above these temperatures vitrification will occur. These data show that the higher the proportion of cement in the mixture, the lower the refractoriness of the final product. It must be kept in mind, however, that within the limits indicated, the higher the proportion of cement in the mix, the higher the mechanical strength of the resulting structure and the more easily is the wet mix moulded into the desired shape. It follows, therefore, that the optimum proportions to be used in a specific instance have to be determined after these two conflicting features have been considered; at the same time remembering that an increase in the maximum size aggregate is an aid to higher strengths.

Thermal Insulation

For the conservation of fuel in the heating of metallurgical furnaces and other units, whether these be heated by electricity, oil, or other fuel, it is advantageous to secure the maximum degree of thermal insulation, and this may be achieved by the use of one or the other of the so-called "insulating concretes." These are generally made up of a high-alumina cement and a

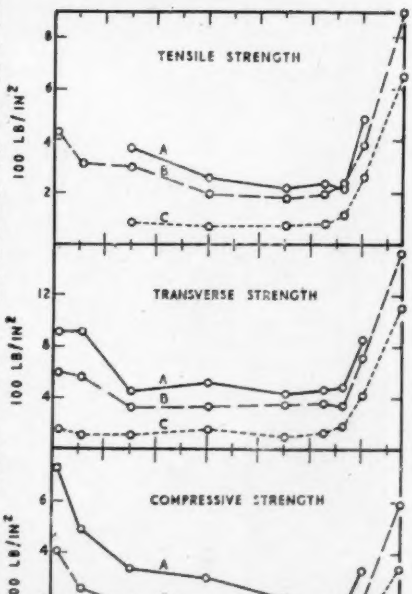


Fig. 1—Comparison of strengths of refractory concrete, using firebrick aggregate, and containing different proportions of high alumina cement, after the following heat-treatments:—24 hr. at 20°C., 24 hr. at 110°C., 4 months at 300°C., 4 months at 600°C., and 5 hr. at all higher temperatures indicated. A—30 per cent cement; B—20 per cent cement; C—10 per cent cement

lightweight aggregate. They have no great strength or abrasion resistance, while, in general, they have a lower fusion point than refractory concretes; the fusion point varying with the type of aggregate used. In many situations where high-alumina cement is to be employed, it is advantageous to combine adequate heat resistance with a high degree of thermal insulation, and both these requirements can be met by using a mix of high alumina cement and an appropriate aggregate. The concretes so produced are used mainly for thermal insulation at higher temperatures, and they may be regarded as lightweight refractory concrete having greater insulating properties but lower strength and abrasion resistance.

The lightweight aggregates used include calcined diatomite and vermiculite, for working temperatures up to 1,000°C.; expanded clay or shale, for temperatures between 1,000°C. and 1,200°C.; and porous fireclay for temperatures not exceeding 1,350°C. Using diatomite, the usual mix consists of four volumes of aggregate, graded from $\frac{3}{16}$ in. to dust, to one volume of high-alumina cement. The density of the placed concrete is about 75 lb/ft^3, and this is reduced to about 60 lb/ft^3 at the operating temperature. Values for the thermal conductivity of this type of concrete are approximately as follows, and are expressed in terms of "K" value (B.Th.U/ft^2/hr/°F/in.):—cold face = 30°C., hot face = 800°C. = 1·9; cold face = 30°C., hot face = 1,000°C = 2·0.

For normal operating conditions where the cold face may be much higher than the foregoing figure, it is customary to take an average "K" value of about 2·0 B.Th.U/ft^2/hr/°F/in. Such a mix has a cast strength of between 2,000 and 2,500 lb/in^2, and a fired strength between 500 and 1,000 lb/in^2. A still higher insulating value is obtained by decreasing the proportion of the cement, at the expense of a lower mechanical strength; while increased mechanical strength can be had by raising the proportion of cement, but simultaneously the insulating value would be decreased.

With vermiculite as the aggregate, an average mix comprises four volumes ($\frac{1}{4}$ in.-20 mesh) to one volume high alumina cement, which in the placed concrete, after drying out, gives a density of 50-60 lb/ft^3, and after firing, from 30-35 lb/ft^3. When used as a high temperature insulating medium, the thermal conductivity is 0·75-1·5 B.Th.U/ft^2/hr/°F/in. Due to the weak nature of the aggregate, no high mechanical strength can be achieved and in practice it is found that the compressive strength after firing to temperatures up to 900°C. is between 200 and 400 lb/in^2. This type of concrete is, therefore customarily employed as a backing-up insulation behind some denser cover such as a refractory concrete.

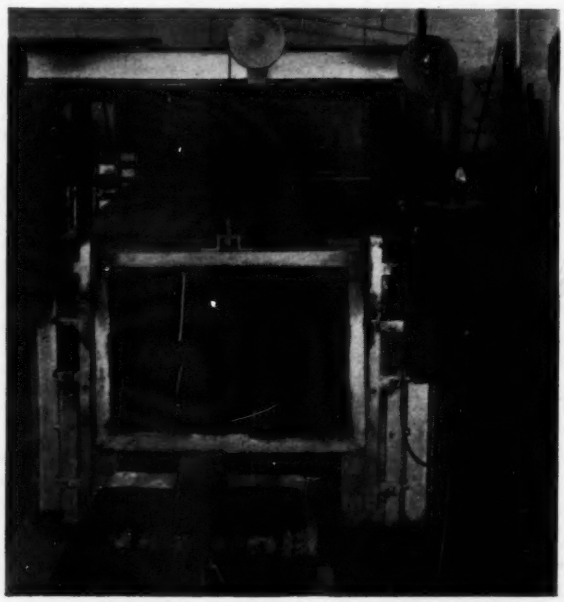
Expanded clay or shale has a pumice-like structure, and the upper temperature limit of concrete made from these materials varies with the properties of the particular clay or shale used and the temperature to which it has been fired in producing its specific structure; this pre-treatment of the material also affects its density and strength. The thermal conductivity of a typical mix, using 4:1, and expressed in terms of "K" value is as follows:—mean temperature 650°C=3·55; mean temperature 760°C =3·57. The fourth type of aggregate, porous fireclay, is commonly employed in furnace construction where it is desired to retain the advantages of castable insulation, but the hot-face temperature is somewhat higher than that which can be handled by the three other types of aggregate.

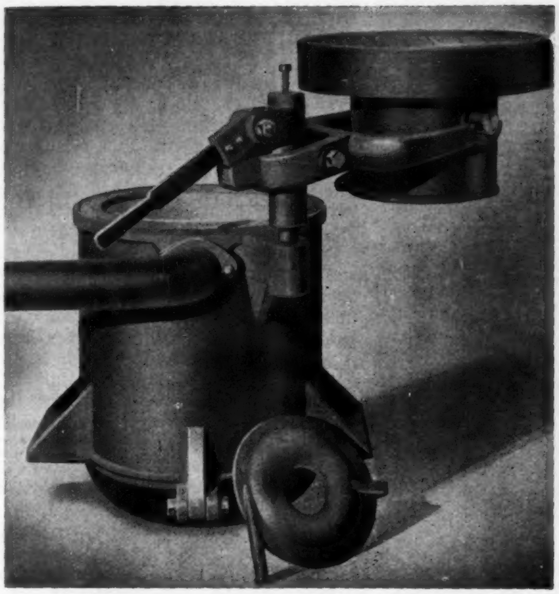
In such a case, it is possible to use porous fireclay which has been produced from a refractory clay or firebrick at a high temperature, and by a process which renders the material cellular or porous; thus giving higher insulation value. A typical aggregate of this description is graded from $\frac{3}{8}$ in. to dust, and the normal mix is 6:1, which gives a density after placing and drying out of about 75 lb/ft^3, and a service density of about 65 lb/ft^3, where the temperature may be as high as 1,350°C. The cold strength of such

Left: Fig. 2—Secar/sillimanite lining to "Efco" low frequency induction furnace

Courtesy: Hepworth and Grandage, Ltd.]

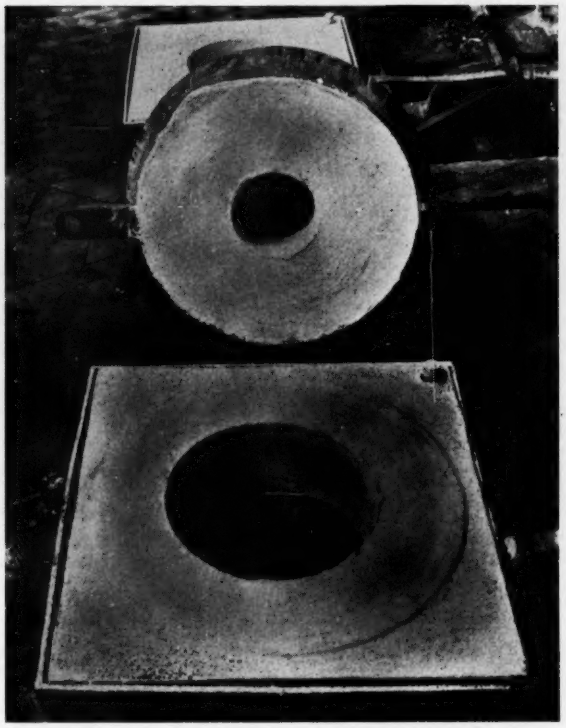
Below: Fig. 3—Cast in situ arch and door of oil-fired annealing furnace, insulating concrete employed *[Courtesy: National Coal Board*





[Courtesy: Midland Monolithic Furnace Lining Co., Ltd.

Above: Fig. 4—Black Seam crucible furnace with high duty castable lining, the preheater inverted for lining and serving as own mould



Right: Fig. 5—Secar/sillimanite lid and lining applied to an oil-fired pit furnace for non-ferrous metals [Courtesy: Lafarge Aluminous Cement Co., Ltd.

a mix is about 700 lb/in^2, which is reduced to between 400 and 500 lb/in^2 in firing. Typical "K" values for thermal conductivity are as follows:—cold face=30°C., hot face=946°C. =2·37; cold face=30°C., hot face =1,109°C=2·44.

For use where resistance to corrosive action of slag or fusible ash is of importance, the mineral sillimanite is often applied in admixture with aluminous cement. Sillimanite itself is lacking in plasticity but this drawback is overcome by the use of the cement. A typical example of the application of sillimanite and "Secar" high-purity white calcium aluminate cement is the lining to the "Efco" low frequency induction furnace, Fig. 2. The working part of the furnace is 6 ft. by 4 ft. by 3 ft. 6 in., the mix for the lining is 7:1, and the life of the lining is approximately 9 weeks, as compared with 10 to 12 days for materials previously employed.

Electric Furnaces

For a number of years there has been a constantly increasing application of castable refractories to the fabrication of electric furnaces, heaters, etc. These refractories consist for the most part of a suitably-sized aggregate or grog, intimately mixed with aluminous cement, and the necessary amount of water to form a mortar or concrete according to the size of the aggregate used. Such mixes are easily mouldable to any desired contour, so that they can be made to conform to any required furnace design, while the material is ready for service at the end of 24 hr. after placing. A feature of these castable materials is that they maintain practically the same size in the final product irrespective of working temperature; so that the initial specific dimensions are maintained at operating temperatures, neither swelling nor shrinkage taking place, and pre-firing before use is not necessary.

A typical application of castable refractories to electric furnace construction is the casting of the holders or supports which carry resistance wire elements. These castings are often of an intricate nature, having numerous recesses for the accommodation of the elements, but the mix can be made to follow accurately the contour of the mould. In casting a simple type of refractory holder, the mould may consist of a baseplate, a frame with detachable sides, and two opposite sides having a number of holes bored through them so that steel rods can be pushed through to mould the grooves or slots which will ultimately carry the resistance wire. A specific shape may be given to the grooves by the use of wooden beading or strips fixed to the baseplate. Some of the mould surfaces may carry a thin film of grease to facilitate their removal without damaging the casting; while the rods are turned periodically during the initial setting of the casting to avoid adhesion of casting and rods, the latter being withdrawn as soon as the casting is hard enough. During the 24 hr. setting period the casting is kept cool and wet by covering with moist clean sacking. A typical mix for such castings is 4 ft^3 to 5 ft^3 crushed firebrick ($\frac{1}{4}$ in. to dust), with 1 ft^3 aluminous cement; aggregate proportions and sizes vary with the application and wall thickness. Holders cast from the mix are suitable for temperatures up to 1,200°C.

When refractories are used for this type of work the question arises as to what are the electrical properties of the casting. Even with the same mix the electrical properties will vary slightly throughout the mass of the casting, due to different proportions of moisture being present in different parts of the material. When in use there will be little moisture present, but atmospheric moisture will collect and be partially absorbed while the castings are out of service. Tests show that the electrical resistivity of refractory concrete is higher than that of the firebrick which forms the aggregate. Typical figures for specific resistivities in megohms/c.c. are:—firebrick at 500°C = 5; at 1,000°C =0·05; refractory concrete at 500°C =16; at 1,000°C=0·10; so that the resistivity of the concrete is more than three times as high as the firebrick at 500°C., and is still twice as high at 1,000°C.

Electrical resistivity is generally found to be higher in concrete made with aluminous cement than when Portland cement is employed. This is believed to be due to several factors, such as the high proportion of free lime which is released in Portland cement. Also, during hydration, the high-alumina cement combines with a greater percentage of water and at a higher speed than is the case with Portland cement. It is thus obvious that while concrete of any description cannot be regarded as a first-class

Fig. 6—Secar/sillimanite lids and linings in oil-fired pit furnaces, melting non-ferrous metals [Courtesy: Fry's Metal Foundries, Ltd.

dielectric material, the refractory type gives a higher degree of electrical insulation than is possible with Portland cement concrete. This relatively high electrical resistivity makes refractory concrete quite suitable for application wherein the electrical properties required are not too stringent. There is also no danger of refractory concrete which is carrying live elements being suddenly disrupted by cold water falling on to it, for the concrete in general has a high resistance to thermal shock. This feature is of value in all furnace structures subjected to extreme fluctuations of temperature. During certain quenching operations, for example, the spraying of cold water on hot concrete does not damage the latter.

This resistance to thermal shock is considered to be due to the "elastic" nature of the cement bond and, although the aggregate may be firebrick of high spalling tendency, this tendency is adumbrated by the action of the cement. The effect of porosity in refractories on thermal stress resistance has been investigated by Coble and Kingery[2], who isolated the effect of porosity from that of other variables by including varying proportions of combustible filler in an alumina casting slip, from which specimens were prepared and fired under identical conditions. In each case, thermal stress resistance was found to decrease with increase of porosity. The practically complete absence of porosity in properly prepared refractory concrete probably contributes to its high resistance to thermal shock.

Furnace Construction

In recent years some large types of furnace have been constructed entirely of refractory concrete, generally with a backing of insulating concrete; but, although the advantages of castable refractories are becoming more widely recognized, it is still common to find these refractories being applied to only parts of a furnace, such as doors, hearths, dampers, arches, etc. For plate-heating furnaces, operating at a temperature of 1,100°C., which are of relatively large dimensions, refractory concrete is in use for doors in place of firebrick; the firebrick door had a life of 2 months, but the concrete door lasts for about 2 years under the same service conditions. In casting large structures of this type, a simple method of door construction is to cast the wet mix in a frame or casing, reinforcement being provided by a series of bolts with large washers at the heads, which are welded on the frame at about 1 ft. spacing. To allow for differential expansion, the bolts and washers are coated with bitumen. As an alternative to this method of construction, a door may be made up of several large precast units. The construction of dampers in numerous designs is also a feasible proposition by the use of castable materials. One application is that of a damper suspended in the arch of a re-heating furnace; the lowering of the damper reduces the effective size of the furnace, so permitting the more economical treatment of small batches.

In the fabrication of arches, covers and lids for furnaces, the refractory concrete may be cast as a monolith at the site, or precast units may be employed. A cast *in situ* example is seen in Fig. 3, depicting an arch and door of an oil-fired annealing furnace. Insulating concrete was used for the main arch, door and cantilevers on the furnace bogie. The arch span is 3 ft. 6 in., length 8 ft., thickness 9 in. at the centre and 12 in. at the sides; the door was filled with insulating concrete in an angle-iron frame. The operating temperature is 900°C., the temperature of the hot face of the arch being 1,000°C. After 2 yr. in service, the furnace was taken down, and the arch was found to be in new condition. Although a crack had developed in the arch after only 2 hr. in use, this did not lead to any deterioration in the unit.

For the construction of the unit, a crushed insulating brick was used as aggregate, a similar mix being employed for the door. At the same establishment, precast refractory concrete ribs were chosen for constructing the complete arch of another oil-fired furnace, operating at 1,200°C.; but a casting technique was employed in producing the hearth and flues forming part of the furnace, the aggregate being high-temperature crushed insulating brick. In this furnace, the arch ribs had a 6 ft. span and were approximately 2 ft. wide by 2 ft. thick. Such ribs are by no means the largest

Fig. 7—Refractory concrete floor withstands radiant heat and repeated spillages of molten metals and slag in a non-ferrous metal foundry (Courtesy: The Anti-Attrition Metal Co., Ltd.

constructed for this work, for some have a greater span and weigh over 3 tons each.

The incorporation of reinforcement for large spans in the construction of flat arches is a practical necessity, and a successful method of doing this has been described by Robson,[3] his technique involving the casting of angle-iron or channel-iron claws in the cooler zone of the refractory concrete. These claws are attached to rolled steel joists and these may be partially buried in the concrete. Near the hot face, use may be made of specially-designed refractory anchors. While reinforcement is not normally necessary in smaller spans, wire mesh may often be advantageously employed in the colder zone. Reinforcement of normal sprung arches is not considered necessary, even in large spans.

Castable refractories are widely employed in the form of precast slabs for covering small furnaces, such as non-ferrous crucible melting furnaces, and a concrete lining in the covers of top-hat annealing furnaces is an appropriate application. Fig. 4 illustrates a crucible furnace lined with a castable refractory, the preheater serving as its own mould. Fig. 5 shows a typical construction after completion of moulding, while Fig. 6 depicts a similar type of furnace in use melting non-ferrous metals. Where underground flues are required in connection with furnace installations, the use of refractory concrete affords good resistance to attack from the products of combustion. At the same time, being monolithic, the concrete forms a gas-tight lining. In installing underground flues, a trench is dug and the bottom covered with a continuous layer of refractory concrete. As soon as this is hard, the necessary prefabricated formwork is arranged on the concrete bottom and the casting of concrete is begun.

Foundry Floors

As refractory concrete is a true refractory and it can be placed just as easily as ordinary concrete, it has become a popular material for foundry floor construction. It will withstand white heat without ill effect; molten metal can be repeatedly spilled on it without any danger of damaging the floor. Such a floor does not require the use of sand as a protective medium, so that the floor remains clean and a source of foundry dust is eliminated. While refractory concrete in a furnace has a temperature limit of around 1,350°C., when used as a floor the concrete can withstand the spillage of metals at much higher temperatures owing to the rapid cooling of the metal on the floor surface. Solidified metal can be removed from the floor and remelted without fear of any excess pick-up from the floor. In Fig. 7 is seen a typical refractory concrete floor which withstands radiant heat and spillages of molten metals and slag in a non-ferrous metal foundry. In spite of comparatively soft aggregate, a properly cured floor of this type should give a wear resistance comparable to an average Portland cement/gravel concrete floor. Where there is any abnormal wear, such as turning points of vehicles, steel plates can be embedded in the concrete, or a special mix may be used.

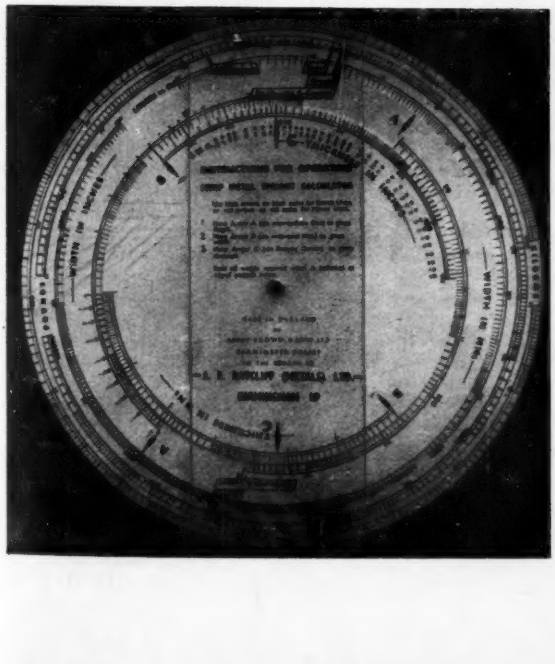
References

1. R. A. Heindl and Z. A. Post; *J. Amer. Cer. Soc.*, 1954, **37**, 206.
2. R. L. Coble and W. D. Kingery; *J. Amer. Cer. Soc.*, 1955, **38**, 33.
3. T. D. Robson; *British Clayworker*, 1954, 741, 302.

Strip Metal Calculations

FOLLOWING the success of the Strip Metal Weight Calculator introduced in 1955 by J. F. Ratcliff (Metals) Ltd., of New Summer Street, Birmingham, 19, a redesigned model has now been introduced. The company had found that two out of every seven enquiries they received specified footage or metreage, and their trade always quotes and sells by weight. The delay involved in conversions by the use of tables, especially in dealing with phoned enquiries, was considerable. The calculator went far to minimize this delay, and in many cases customers made the conversion themselves. It is quick and simple to use; in three quick moves it calculates any given length of metal strip of a known width and thickness into weight, or *vice versa*, and operates in British or metric systems, or, if necessary, a combination of both.

Its range covers any length between 10 ft. and 3,000 ft., at any width from $\frac{3}{16}$ in. to 36 in., at thicknesses from 0·002 in. to 0·2 in., giving conversions from $\frac{1}{2}$ lb. to 100,000 lb. It may be used for aluminium, steel, copper, brass and bronze.



The strip metal weight calculator, of which a new version has been issued by J. F. Ratcliff (Metals) Limited

Basically, the new model will not do anything more than the original, but many improvements have been made in detail.

The revolving discs have been increased in thickness to minimize any warping which could occur in tropical conditions. The directions (which rather tend to become redundant after three or so calculations) are now at the front of the calculator, and the space made available at the rear now includes an additional and useful conversion table for fractions, decimals of an inch and millimetres over a wide range.

The new model's working directions are covered by moving three arrows only, clearly marked A, B and C, thus making the conversion extremely simple.

Obituary

Mr. F. G. Woollard

WE regret to record the death, at the age of 74, of Mr. Frank G. Woollard, a world authority on automation who, before his retirement, was a director of the Birmingham Aluminium Casting Co. Ltd., and the Midland Motor Cylinder Co. Ltd. A past-president of the Institution of Automobile Engineers and chairman of the Zinc Alloy Die-Casters Association, Mr. Woollard took a keen interest in education for industrial administration and conducted a number of study groups at the College of Technology, Birmingham.

Research Progress

Production of Metallic Thorium

BY RECORDER

A NUMBER of reactive metals, including uranium, zirconium, thorium, etc., have been studied intensively in recent years because of their importance in nuclear energy applications. Some are of interest as shielding or structural materials, e.g. zirconium, others as nuclear fuels. Although the isotopes and the "artificial" fission products of uranium have so far provided the prime sources of atomic energy, it is fairly clear that fuels derived from thorium will eventually be extensively used in nuclear reactors. It is possible that these requirements will be satisfied by the use of thorium compounds, e.g. thoria, but metallic thorium may have certain advantages that would justify its production in relatively large quantities.

Like many of the metals useful in this field, thorium is not easy to prepare free from contaminants, particularly oxygen, and complete exclusion of air during any high temperature reduction step is essential.

Magnesium Reduction

It has been found that the most convenient compound of thorium to use as a starting material for reduction to metal is the tetrachloride which can be obtained in a pure form by relatively simple chemical processes. Thorium can be obtained from this substance in several ways, but only two are likely to be of practical importance: first, by reduction with calcium, magnesium or sodium, and second by electrolysis. Brief details of the magnesium reduction of thorium tetrachloride have been given by A. R. Gibson and J. H. Buddery, of the U.K. Atomic Energy Authority, in a Symposium arranged by the Institution of Mining and Metallurgy.[1] No particular difficulty seems to have been encountered and it might be assumed that the process could be operated on a large scale, probably using plant generally similar to that employed for the commercial production of titanium or zirconium. Thorium tetrachloride differs from titanium and zirconium tetrachloride, however, in that it neither boils nor sublimes at relatively low temperatures, having, in fact, a melting point of about 780°C. and boiling only above about 920°C. Furthermore, intermetallic compounds of great stability are known to exist in the magnesium-thorium system, so that it is difficult during the magnesium reduction to prevent the formation of such compounds and to avoid appreciable magnesium losses from this cause.

Electrolytic Process

Although apparently satisfactory thorium metal has been produced by magnesium reduction, Gibson and Buddery admit that the method has disadvantages and suggest that an electrolytic process might be used more successfully. They succeeded in obtaining thorium by electrolysing a melt of thorium tetrachloride in a mixture of sodium and potassium chlorides at 750-800°C. Cathode current efficiencies exceeding 80 per cent on occasion were obtained, using a potential of 3-3·5 V. Unfortunately, no details of the cell construction and operation are given by the authors.

These brief details can now be compared with similar American work described by B. C. Raynes *et al*[2] of Horizons Inc., Cleveland. In their largest cell 50 lb. of electrolyte was held in a graphite crucible heated by means of a graphite resistor. The electrolyte was a simple mixture of thorium tetrachloride and sodium chloride in such proportion that the optimum thorium ion concentration of 10-15 per cent was present. The anode connection was made direct to the cell and the cathode consisted of a steel or Hastelloy C cylinder welded to a nickel rod, which was protected from attack by chlorine by means of a graphite sleeve.

In operation, the cell was charged and an argon atmosphere established. Melting the electrolyte followed, taking 1½-2 hr., the cathode was inserted with a polarizing voltage of about 2·5 V and electrolysis started by increasing this voltage. To terminate the run, the cathode was retracted into the argon-filled space above the melt and the whole cell allowed to cool. The optimum cathode current density using the optimum thorium ion concentration lay in the range 300-400 amp/dm^2. Although these values are appreciably higher than those used by Gibson and Buddery, it may be presumed that they were not sufficiently high to provide any considerable part of the heat required to keep the bath molten, but Raynes *et al* do not comment on the effects of using current densities large enough to serve this purpose. Some figures are given, however, for the cathode current efficiencies obtained, from which it appears that a value of 60 per cent or so was usually obtained. In addition to the electrolysing current, the power used for heating would also have to be taken into account for an economic valuation of the process.

Again, no details are given of the methods used to extract the thorium deposited on the cathode, but apparently "a granular coarsely crystalline metal" could be obtained relatively free of electrolyte salts. The powder contained about 0·01-0·03 per cent each of calcium, sodium, iron and silicon, and about 0·002 per cent each of aluminium, copper, nickel and carbon. It was also found that a residue was obtained after solution in concentrated hydrochloric acid, which was presumed to consist mainly of silica and thoria. The insoluble residue amounted to 0·2 per cent of a sample having a Rockwell B hardness of 10 and to 3·1 per cent in a powder of Rockwell B 31.

The granules were found to compact easily into a form suitable for melting, though it was found that briquettes, when heated *in vacuo* at 1,000-1,400°C. gave rise to pressure changes, probably caused by the evolution of residual salts. The melted material gave buttons with hardnesses ranging from 70 Rockwell B down to as low as 5 Rockwell B (stated to be equivalent to 68 V.P.N.), and the authors suggest that the average hardness of thorium produced by the process should lie in the range 70-80 V.P.N. Although this estimate was made "from a consideration of the many runs made," the bulk of the hardness values quoted in the Paper are greater than about 30 Rockwell B and the upper limit of the average hardness range likely to be achieved would seem to be nearer 100 than 80 V.P.N. Be that as it may, the metal when melted was apparently quite ductile and could be cold-worked with ease. An arc-melted(?) button was cold-rolled to a reduction of 84·5 per cent, the hardness rising from Rockwell B 30 to Rockwell B 71. A sample, induction melted in a beryllia crucible *in vacuo*, was hot-rolled to ⅛ in. thickness, cold-rolled to 0·040 in. and annealed for 1 hr. at 600°C. *in vacuo*. Tensile specimens gave an average ultimate strength of about 23·3 tons/in^2 and an elongation (in a 1 in. gauge length) of 11·2 per cent.

It is unfortunate that Raynes *et al* give so few details in their Paper relating to the particular difficulties confronting a process of this type. It does not seem unfair to suggest that once the method has been shown to be workable on the scale of a few grams,

(Continued on page 11)

Pressure Die-Casting Review

Difficult Casting Problems

WAYS and means frequently have to be found for manufacturing parts which, at first sight, appear to be well-nigh impossible to produce on an economical basis. In many instances, recourse has to be made to one of the newer casting techniques which offer good surface finish with the ability to reproduce intricate detail. Although not precisely a "new" technique, pressure die-casting has so much to offer in the solution of difficult manufacturing problems that in many cases it is the process to which designers first turn their attention, and this especially so if a high production of a given component is envisaged.

One such example is the spray gun shown diagrammatically in Fig. 1, which involves certain features which make it a difficult casting proposition. For instance, the position of the inserts, both of which are in high tensile brass, make it imperative that they are machined as completely as possible before being cast in position. For the same reason a forging, although producing the required shape without the need for inserts, would be almost impossible, or at least costly, to machine. A brief examination of the position of bores, internal and external threads, etc., will make this clear. Even the general contours of this gun body make it difficult to jig for a turning or boring operation, and the bores and threads at *A* and the external threads *B* are, in any case, not readily approachable by reason of the shrouding effect of the casting shape.

The Bullows-Binks Model 19 spray gun. The body and handle are formed from a single die-casting

It was clear from a study of the design necessary for efficient spraying that to produce an economic product the difficulties involved must be overcome prior to forming the finished part, and pressure die-casting, with the possibilities it offered for the use of cast-in inserts, appeared to be the solution. The inserts, as originally conceived, were made from hot brass stampings almost fully machined prior to casting. This proved quite successful, although certain casting difficulties connected with running and feeding were originally encountered.

Later, the boss on the side of the insert *A* was found to be unnecessary, as difficulties expected with coring the long bore did not arise. This enabled the insert *A* to be produced as a piece fully machined from bar stock —a considerable economy.

One major problem still remained to be solved. It was found at a very early stage that the flow of hot metal impinging on the insert *A* was softening the insert, causing distortion of the internal bore and threads. Other positions were considered for the gate but no satisfactory alternative could be found and it was finally agreed between the die-caster and the manufacturers of the gun—Alfred Bullows and Sons Limited, of Long Street, Walsall—that a support plug, screwed into the insert during the casting cycle, would obviate the trouble. This method was, in fact, adopted and a

Fig. 1—Diagram showing the position of the cast-in inserts

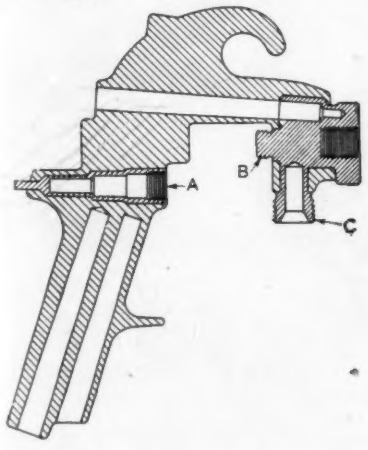


Fig. 2—The finished die-casting which forms the body and handle of the spray gun

Fig. 3—Another spray gun handle, previously sand cast in aluminium alloy now produced as a die-casting in zinc alloy

satisfactory casting produced, as shown in Fig. 2.

Another problem which had been expected was that there might be a tendency to leakage at the interface of the brass and aluminium under air pressures up to 100 lb/in^2. This, however, was overcome by the provision of circumferential grooves on the insert, and no trouble has been experienced.

As-cast, the bores shown in Fig. 1 are included, as also is the external detail visible in Fig. 2, and, as in most die-castings, this incorporated detail, and the good casting finish, which necessitates only a light scurfing, contribute to the economy of the product.

It should, perhaps, be emphasized that the service requirements for this model of spray gun are fairly exacting. Intended for the high coverage rates necessary in the automobile industry, in the manufacture of refrigerators and similar products, it has to be light in weight, robust, and its operating mechanism able to withstand considerable wear. It must also permit easy and constant interchange of nozzles, and it is for this reason that high tensile brass is used for the inserts.

Although quite different from the gun just described, the handle shown in Fig. 3 is also of interest as an example of economy provided by pressure die-casting. Now in zinc alloy, this handle was previously sand cast in aluminium. This necessitated the machining of the hexagonal aperture and the trimming of the inside of the other end. As now produced, the section has been thinned down so that the handle is no heavier than the previous aluminium one, and the only operation performed on it is a light skim across the face at the open end.

Die-Cast Air Pistol

FEW industries have welcomed the possibilities opened up by pressure die-casting more than the toy industry, and very early in the history of this process die-castings were being widely used in toy manufacture. Now that pressure die-castings in various alloys are being so extensively used, the toy trade die-castings tend to be dismissed, particularly among engineers, as commonplace. Closely linked with the toy trade are a number of products which may not strictly be regarded as toys yet do not fall fully into the category of sports equipment, and some of these exhibit to considerable advantage the particular features for which pressure die-casting has become so generally esteemed. One such example is the "Gat" air pistol, a product of T. J. Harrison and Son, which uses in its assembly the four die-castings shown in the accompanying pictures.

The body of this gun, cast in zinc alloy, forms the barrel, cylinder and half the trigger guard and grip. A second casting forms the other part of the trigger guard and grip, the other two castings being the cylinder and the trigger.

The body has the barrel cored to size from either end, the bore at the rear end being $\frac{3}{4}$ in. and at the front $\frac{3}{16}$ in., the two diameters being separated by a cast-in web with a smaller hole through its centre. The forward part of the barrel houses the cylinder shown on the left, the rear portion housing the stem and trigger lock.

In the half grip, bosses are provided for housing the trigger pivot, the trigger release pawl, and two fixing screws which secure the handle. A rectangular recess is provided, also cast-in, for the pawl return spring, and a rectangular aperture is cored into the rear end of the barrel for the pawl. On the outer side of the grip, a cast-in knurl is provided, and a small panel on one side bears the words "The Gat" in raised letters; on the other side, a similar panel carries the makers' initials, etc.

The cylinder on the left is hollow, and is partially closed at one end.

The die-castings all in zinc alloy, which are used in the "Gat" air pistol

The finished "Gat" air pistol

In the finished pistol, it houses the spring assembly which provides the compression for firing.

The remaining casting, the trigger, has cast-in pivots which locate in the cored bosses in the body and grip one arm which forms the trigger and another which is forked at its end to house the end of the trigger release pawl.

Men and Metals

Featured in the New Year Honours List are the following personalities in the metallurgical and engineering fields:—

KNIGHTS BACHELOR—**W. R. J. Cook** (deputy director, Atomic Weapons Research Establishment, Aldermaston); **S. J. Harley** (chairman and managing director, Coventry Gauge and Tool Company Limited); **W. J. Worboys** (director, Imperial Chemical Industries Limited and vice-president, Associated British Chemical Manufacturers).

K.C.B.—**H. W. Melville** (secretary, Department of Scientific and Industrial Research).

C.B.E. — **E. H. Ball** (managing director, British Thomson-Houston Company Limited); **R. W. West** (principal, Battersea College of Technology).

O.B.E.—**R. A. F. Hammond** (principal scientific officer, Armament Research and Development Establishment, Ministry of Supply); **H. Seligman** (Head of Isotope Division, Harwell); **W. Swift** (director, Joseph Lucas Gas Turbine Equipment Limited).

M.B.E. — **J. Rutherford** (foundry manager, Wm. Beardmore and Company Limited).

B.E.M. — **C. I. Beech** (foreman, British Chrome and Chemicals Limited); **J. Foster** (master stamper, Garringtons Limited); **B. T. Walker** (tool maker, Thomas Bolton and Sons Limited).

New directors appointed to the board of Mappin and Webb Limited are **Mr. C. C. Allen, Mr. W. H. Gilbert, Mr. A. O. Wall** and **Mr. C. A. Lyon.** It is understood that Mr. Lyon will continue as secretary to the company.

At the annual meeting of the Aluminium Industry Council, held in London recently, **Mr. H. G. Herrington,** C.B.E., managing director, High Duty Alloys Limited, was unanimously re-appointed to serve a second term as chairman of council.

Formerly of the Research Division of High Duty Alloys Limited, **Mr. J. M. Kape,** B.Sc., A.R.I.C., L.I.M., has joined Alumilite and Alzak Limited as chief research and development chemist.

Appointed to the board of directors of Vickers Limited, **Mr. A. H. Hird,** B.Sc., M.I.Mech.E., A.C.G.I., is also a director of Vickers-Armstrongs Limited and Metropolitan-Cammell Carriage and Wagon Company Limited, and chairman of several wholly-owned subsidiaries of Vickers Limited.

Previously with Fielding and Platt Limited, **Mr. W. A. C. McIntyre** has joined the board of Reed Brothers (Engineering) Limited, where he will be chiefly responsible for the expansion of the manufacturing programme of hydraulic presses of all types made by this company.

It is understood that **Mr. A. R. Mathias** has been appointed a director of Henry Gardner and Company Limited as from January 1.

Officially announced is the appointment of **Dr. H. W. Melville,** F.R.S., to succeed **Sir Ben Lockspeiser,** K.C.B., F.R.S., as one of the British Government's delegates to the Council of the European Organization for Nuclear Research. Dr. Melville is at present secretary of the Department of Scientific and Industrial Research.

Now that the amalgamation of British Chrome and Brothertons has become effective, **Mr. J. T. Barrie, Mr. G. Brotherton-Ratcliffe, Dr. C. H. Clarke** and **Mr. A. Henderson** have been appointed to the board of British Chrome and Chemicals (Holdings) Limited. **Mr. E. P. K. Potter** has relinquished his directorship of that company but remains a director of British Chrome and Chemicals Limited.

Chairman of the fourteen-factory Dohm group of engineering companies, **Mr. S. A. Dohm** is making a trip to Africa in accordance with his policy of maintaining close personal touch with friends and business affiliates in all parts of the world, as a background to the extensive network of business contacts in the 70 countries to which his companies export.

Interesting news reaches us from New York to the effect that **Dr. William J. Kroll** has been awarded the 1958 Perkin Medal of the American Society of Chemical Industry, and this will be presented to him on Friday next (January 10) at a dinner in his honour at the Waldorf-Astoria Hotel. Dr. Kroll will be remembered as the developer of the basic Kroll process used for producing metallic titanium and zirconium.

It is announced that **Mr. J. E. C. Bailey,** C.B.E., chairman and managing director of Baird and Tatlock (London) Limited and Hopkin and Williams Limited is to visit his companies' branches, agents and representatives in Rhodesia, South Africa, Australia, New Zealand, Singapore and Ceylon. He is leaving on his tour in a few days' time.

Research Progress

—continued from page 8

no especial trouble should be experienced in enlarging the cell to the point where a batch process producing a few pounds of metal per run can be operated. To extend this further, however, becomes increasingly difficult, *vide* experience with the electrolytic extraction of titanium or zirconium. Commercial success depends on more or less continuous operation of the cell, a construction that is robust and almost immune from the type of failure that could cause irremediable contamination of the bath, and economic power utilization—for instance, the electrolyte should preferably be kept molten by the electrolysing current. More information on these aspects would greatly enhance the value of Papers of this type.

References

[1] A. R. Gibson and J. H. Buddery; "Extraction and Refining of the Rarer Metals," Inst. Min. Met., London, 1957.

[2] B. C. Raynes *et al*; *J. Metals*, 1957, 9 (10), 1373.

A REVIEW OF NON-FERROUS ACTIVITIES IN 1957

Base Metal Markets

BY OUR METAL EXCHANGE CORRESPONDENT

ALTHOUGH consumption of copper kept up well last year there was a decline in the usage of aluminium, and stocks showed a tendency to increase. Conditions in tin, zinc and lead were fairly good, but it was noticeable that buyers showed caution and this applied also to purchasing in copper. Outstanding features of the year were the worsening of the economic situation in this country, the persistent weakness on Wall Street for much of the period, and the operation of the Tin Pool. By August, it was obvious that matters were approaching a near crisis on the economic front and there was persistent talk of the likelihood of devaluation of the £. In consequence prices on the Metal Exchange advanced but the rise was not held when it was realized that fears about the pound were unlikely to materialize. Then came the increase in Bank Rate to 7 per cent on September 19, together with the announcement of various measures to be taken by the Government in order to combat inflation. In the United States there was evidence during the second half of the year that business and industrial activity were declining and this brought about continuous selling of securities on Wall Street. Although no slump was envisaged, something very like a recession was in evidence which would most likely persist well into 1958.

The R.S.T. stability and fixed price scheme for copper came to an end on October 7, after a run of some 2½ years, its termination being at the request of the consumers. This event, coupled with the abandonment of the talks between the two Rhodesian producers on the question of a joint selling price acceptable to the users of the metal raised the prestige of the London Metal Exchange to a not inconsiderable extent and it is not too much to say that last year the futures market in Whittington Avenue increased in popularity. So much so that during the autumn the possibility of introducing aluminium on to the Metal Exchange was canvassed. The matter did not get beyond the stage of theoretical consideration, but it is believed that the Committee of the Exchange are giving some thought to the possibility of such a development. In view of increasing supplies of aluminium and some falling off in demand during last year, the plan is by no means out of the question. After all the function of the Metal Exchange is to take care of surpluses and at the moment there appears to be too much aluminium.

The year just closed saw the usual crop of labour trouble both at home and abroad, but the consumption figures of the four non-ferrous metals traded on the Exchange will prove to be quite good. Copper and tin both came under the influence of strikes, short lived for the most part, or the threat of strikes, but there was no major or sustained hiatus in production. The Board of Trade gave notice of the release of various parcels of metal from the stockpile and a considerable tonnage was, in fact, sold on the basis of competitive tendering. During the second half of the year there was a big build-up in the Metal Exchange warehouse stocks of both tin and copper, the prospect being that those tonnages, already large, will increase still further. In the States stockpiling began to taper off and the closing weeks of the year witnessed the prosecution of a campaign to increase the import duties on lead and zinc, while there was also a good deal of talk about the chances of the import duty on copper being invoked. There was a general improvement in nickel supplies and the "free market" price eased off considerably while the British Government announced the release of nickel from the stockpile. During the second half of the year markets were mostly depressed, copper, lead and zinc setting up new low records since the resumption of trading in futures.

Copper

At no time last year was the backwardation serious, being little more than £2 at any time during the first quarter, after which a contango gradually emerged which expanded to around £4 to £4 10s. 0d., during the closing months of the year. This was largely due to the expanding total of stocks in Metal Exchange official warehouses which after declining somewhat during the first quarter turned round and mounted rapidly until towards the end of the year the total stood at around 20,000 tons. This compares with about 4,000 tons at the beginning of the year and much of the increase came from deliveries of copper by consumers who, finding themselves with too much metal, sold on the Metal Exchange to lighten the load. The year opened with cash copper at £267 and the R.S.T. quotation at £270, but a firmer tone took cash up to £273 10s. 0d.; lack of business, however, and weakness in the U.S. price brought this down to £252 10s. 0d. by the month end. U.K. consumption of copper during January was 51,118 tons, of which 10,470 consisted of scrap. On February 1 the R.S.T. price was cut to £250, and again to £240 on February 19, in view of the easy tone of the market which touched a low point of £241 during the month. The American producers reduced to 32 cents, at which level the custom smelters also stood. The world copper statistics for February were poor and Phelps Dodge announced curtailment in production of about 4 per cent. The month of March closed at £241 5s. 0d., after a low point of £235 10s. 0d. During March there were some signs of influential support being given to the market by way of buying in the ring. At the end of April the cash price stood at £240, but had been as high as £246 during the month. Not much change was seen in May, the close being £236 10s. 0d., and during this month a joint selling agreement for submission to their customers was concluded by Anglo-American and Rhodesian Selection Trust.

A 10 per cent cut in production was announced by R.S.T. to date from June 1, but this news did little to help the market for by the end of the month the cash price was down to £217 5s. 0d., with 3 months 25s. dearer. Early in the month there was a statement that the U.S. producers had no intention of cutting Chilean output.

On June 17 the R.S.T. price was cut by £10 to £230, and before the end of the month the U.S. producers came down to 29½ cents, with the custom smelters at 29 cents. Stocks in L.M.E. warehouses at June 30 were 10,272 tons, an increase of nearly 3,000 tons on the month. In July the market weakened further with American dealers offering copper at 27¾ cents while the U.K. price was £213 for cash on July 31. There was a contango of £2 15s. 0d. On July 1 R.S.T. cut to £220 and the Belgian price fell 1 franc per kilo to 30½ francs. Early in the month there was a meeting of copper users to discuss the Rhodesian producers joint selling scheme and it was reported that counter proposals would be put forward. In mid-month there was a report that it was improbable Chile would reduce her output which was estimated for 1957 at 440,000 metric tons. On July 22 trouble broke out on the copperbelt and it was announced that every mine would be closed down pending a settlement of the dispute. Governmental mediation fortunately proved successful within a short time so that there was a fairly speedy return to work. August saw a further reduction of £10 in the R.S.T. quotation and the month ended with cash at £202 15s. 0d. and 3 months at £205 5s. 0d. Early in the month the U.S. producers reduced to 28½ cents but by the end of the month custom smelters were down to 27 cents.

At August 31 Metal Exchange warehouse stocks were up practically to 15,000 tons and sentiment was bearish for on August 20 there was an announcement that the Board of Trade would dispose of 27,000 tons of copper spread over 10 months from October onwards. Half way through the month

there was an upturn on the standard market due to fears that the £ would be devalued and the three months price went as high as £215 10s. 0d., but the rally was short lived. September saw considerable price fluctuations, for following a drop to 26½ cents by the custom smelters the producers reduced to 27 cents and on September 9 the London market bottomed at £183 cash and £186 three months. Following this the smelters reduced again to 25 cents, but within a few days they were up to 26 cents again on New York reports of better consumer demand. Our market strengthened considerably and the R.S.T. price which had fallen to £190, was raised to £200 again. Furthermore, the Board of Trade announced it would not sell any copper for the present, but would review the position again at the end of the year. On September 17 Phelps Dodge announced a 5 per cent cut. Finally, the month closed with cash copper at £191 and stocks at nearly 18,000 tons. Following the ending of the R.S.T. scheme on October 7, the market drifted downwards to touch bottom at £179 10s. 0d., for cash, and £183 three months. The high points were £193 10s. 0d. and £197 respectively, but the close was no better than £188 10s. 0d. cash. November was another month of fluctuations, three months ranging between £187 10s. 0d. and £199 10s. 0d. News of the President's sudden illness came as a shock and the month closed at £184 10s. 0d. cash and £189 three months. December saw L.M.E. stocks increasing again and on the afternoon session of December 11 a new low point since the opening of the market was reached at £176 for cash and £180 5s. 0d. three months. The threat of a strike at El Teniente was speedily removed, but on December 16 there was something of a bombshell when Kennecott announced a cut effective in January, at the rate of 12 per cent equal to about 3,800 short tons monthly. A sharp rise followed, but within a few days the cash price was below £180 again.

Tin

The year opened with cash tin at £778 and forward £10 cheaper, but the threat of a strike at the Butterworth smelter caused an advance to a high level of £804. The Texas Smelters closed down on January 31 after 15 years. Stocks of tin in L.M.E. warehouses were low, less than 500 tons in mid-February, during which month cash dropped to £754 and forward to £741, but the close was above this level. The relative weakness in tin was due, no doubt, to the cessation of stockpiling of the metal in the United States and during March cash touched £757, but was as high as £796. Stocks had risen to 700 tons. During March it was announced that new limits had been agreed by the Tin Council in line with which the Tin Pool manager was obliged to buy at or below £730. Selling could begin at £830. The market was fairly steady through April, and with rising stocks, the backwardation disappeared at the end of the month. By mid-May the total in L.M.E. warehouses was over 1,500 tons, but a small backwardation returned and during the month the quotation moved between £760 and £770. Little change occurred in June, but the Canadian Government announced its intention to release 3,000 tons of tin from the stockpile after six months notice had expired. It was anticipated the metal would be absorbed in Canada. At the end of July stocks stood at 3,000 tons and the price was £744 cash and £743 three months.

By the end of August stocks were heading for 4,000 tons and the quotation had dropped to £736. On the afternoon market of September 26, a £6 "back" appeared and on the following day this widened to £9. By early the following week the squeeze that had developed was adjusted but the market had a bit of a scare. L.M.E. stocks were high, but it was evident that much of this metal was held by the Pool, which had been, it was generally supposed, buying earlier in the year, when the price was higher. At the end of October stocks were in the neighbourhood of 3,600 tons, but during this month pressure developed against the forward position which fell below £725, cash being held at £730 through support buying by the Tin Pool manager. November was a "key" month for tin inasmuch as fears developed, mainly in Singapore, that the Tin Council would be cleaned out and unable to hold the price at £730. It was thought there was some doubt about the call up of the next 5,000 tons of tin after the 10,000 tons level had been reached and the three months position was heavily sold, finally touching bottom at £686 on November 25. However, the date of the Council meeting was brought forward but before that took place the market recovered dramatically and November ended with three months at £718. Finally, it became known that the Tin Pool manager had called for the next instalment of 5,000 tons of metal or its equivalent in cash, but more than that, it was announced that tin export quotas would be imposed. For the period December 15 to March 14, the total permissible export amount was fixed at 27,000 tons, representing a reduction of about 28½ per cent. The forward quotation moved up sharply finally reaching £742 10s. 0d., on December 16, a £10 contango being established. Just before Christmas stocks of tin in L.M.E. warehouses stood at 11,612 tons.

Lead

The year opened at £117, but by the end of February the price had declined to £112. On January 23 the Board of Trade announced its intention to release 30,000 tons of lead starting in March and spread over 9 months. Little price change was seen in March, but April saw a downward drift developing and £108 was reached, followed by some recovery. Imports that month, mainly from Australia, were about 20,500 tons. In mid-May the American quotation was cut by ½ cent to 15½ cents and a couple of days later by a further ½ cent to 15 cents. The price tumbled swiftly in London until £94 15s. 0d. was reached. In June, however, the price fell further for the U.S. quotation came down to 14 cents and at the end of the month prompt lead fell below £90. July saw the fall continuing, but the tone was steadier and this continued through August and September although at the end of that month the price was again below £90. In mid-October the U.S. price was cut by ½ cent to 13½ cents and in London the quotation dropped to £84, being depressed by the news that the Board of Trade intended to sell a further 20,000 tons. This, coupled with fears about an increase in the U.S. tariff, was a depressing factor and by the end of November the price was below £80. Before the year ended the American price was down to 13 cents and acute weakness in London brought the quotation below £70, from which there was however some recovery.

Zinc

Throughout most of the year zinc was under the influence of events in the United States, first as to the likelihood that stockpiling would be abandoned and latterly on account of the uncertainty attaching to tariff adjustments. The year opened on a firm note with the price around £100. During January a temporary squeeze occurring on the last trading day of the first half month pushed the prompt price up to £105 15s. 0d., forward being £99 10s. 0d. February saw lower prices in the absence of buying by America on the barter plan and in March the quotation was around £97. Early in May the market suffered a £5 drop, supplies being plentiful. Russian high grade arrivals had transformed the situation in that grade and the premium was down nearly to pre-war. Later in May the U.S. price was cut by 1½ cents to 12 cents and the London market crashed badly. The current half month's quotation fell to £85 10s. 0d., which was £13 15s. 0d. below the price ruling 10 days previously. Early June saw further weakness with the backwardation in to £1 12s. 6d. In the States the price was down to 11 cents and weakness continued in London. Early in July the quotation stood at around £72. Further cuts each of 50 points brought the U.S. quotation to 10 cents. Later in the month a strike in Belgium helped the London market but its settlement and fears of a further cut in the U.S. price brought about a relapse. At the beginning of August the Board of Trade announced a sale of 27,000 tons over 9 months. In September the price was £73, and in October £71, but it fell below that level to £68 10s. 0d. Further weakness followed and in December the market touched bottom at £61 5s. 0d., prompt, and £61 10s. 0d. forward.

Industrial News *Home and Overseas*

New Aluminium Smelter

Less than 20 months after work commenced on clearing the site, the first metal was poured on December 23 last at the new aluminium smelter of the Canadian British Aluminium Company at Baie Comeau in the Province of Quebec, on the north shore of the St. Lawrence River, 400 miles north-east of Montreal. One of Britain's most important investments in Canada in recent years, the company is a subsidiary of **The British Aluminium Company Limited** and has been formed in partnership with one of Canada's largest pulp and paper companies, the Quebec North Shore Paper Company.

The event marked the completion of the first of four production stages of the £50 million plant which will eventually have an annual capacity of 160,000 long tons of virgin aluminium ingot. As an indication of the size of the smelter, this ultimate capacity represents two-thirds of the present annual consumption of virgin aluminium ingot in the United Kingdom.

The short time required to bring the first stage into production makes the Baie Comeau smelter one of the fastest-built major projects on record. Work began on clearing and building access roads to the site in the severe Canadian winter conditions in 1956. A wharf capable of berthing three 10,000 ton ships has been built, with a belt conveyor system 3,000 ft. long to carry raw materials, such as petroleum, coke and alumina, from the dockside to the smelter. At the same time, a new major housing development has been undertaken and a staff-house, three blocks of apartments and over 200 houses have been built for the company staff. During construction, more than 3,000 workers have been housed in a camp on the site.

The first stage of the smelter, with a capacity of 40,000 long tons a year, like the other three stages still to come, has two furnace bays each a third of a mile long. Designed to be one of the most modern aluminium reduction works in the world, it is provided with a high degree of mechanization and automatic control.

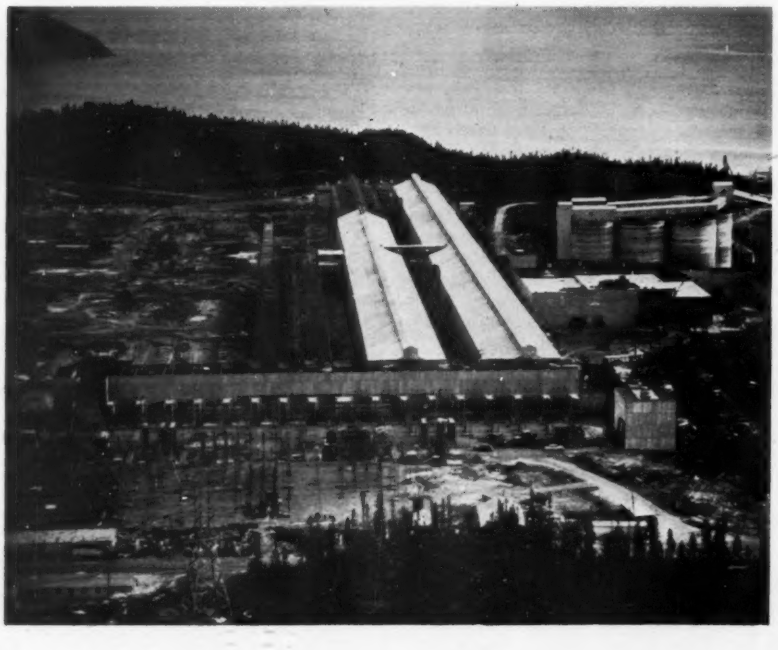
Power for the present requirements of the smelter is supplied from the hydro-electric installation of the Manicouagan Power Company, 11 miles away, where a major expansion programme has just been completed to serve the new smelter involving an extension of the McCormick Dam and the installation of three new 50,000 h.p. generators, bringing the total generating capacity of the Power Company up to 250,000 h.p.

The staff of the company living in the new township, which will ultimately include a church, a school, parks and a shopping centre, includes technicians from The British Aluminium Co. Ltd., mostly from the Highland Reduction Works in Scotland.

Work on the second stage of the smelter is already well advanced and will be completed by the early spring of 1959, when the company will have a production capacity of 80,000 tons a year of virgin aluminium. Later, the company expects to go ahead with the two final stages.

The general contractors for the construction of the smelter are Anglin-Atlas Limited, a joint undertaking of the Anglin Norcross Corporation and Atlas Construction Limited, two well known contracting firms of Montreal. The wharf was constructed by Sir Robert McAlpine and Sons (Canada) Limited. Amongst U.K suppliers, large contracts were obtained by Redpath, Brown for steel work, The English Electric Company for switchgear and transformers and British Thomson-Houston for rectifier equipment, while the Cement Marketing Board of Great Britain supplied 24,000 tons of the cement used. Rigidal corrugated aluminium sheeting for the roofing and siding of the furnace bays and the raw materials conveyors and cast and extruded bus-bars for electrical purposes have been supplied from the British Aluminium Company's mills in the United Kingdom.

A recent view of the first two of the eight smelter bays at Baie Comeau. The third bay is also under construction. The switchyard is in the foreground with the rectifier room running horizontally across the rear end of the smelter bays. Ancillary buildings and alumina silos are on the right



Copper Sales

It was announced by the Board of Trade in September last that in view of the disturbed state of the copper market they had decided not to offer for sale for the time being any of the 27,000 tons of copper which had previously been announced as available. The Board then said that they would review this decision towards the end of the year. This review has now been made and the Board have decided on a further postponement. An announcement will be made when it is decided to resume sales.

Vanadium Oxide

A new 98 per cent vanadium oxide has been added to the extensive list of alloys and metals available from the Alloys Division of Union Carbide Limited. This product is of special interest to ferro alloy producers and manufacturers of ferrous and non-ferrous alloys. The new grade represents a marked improvement over former grades which average 86-89 per cent V_2O_5. The reduction of alkali oxide content to not more than 2 per cent is important to furnace operations because of the appreciable elimination of fume hazards caused by these oxides.

The 98 per cent vanadium oxide also offers advantages in reduced sulphur content, silica content and other contaminants which have a direct bearing on the production of high-quality vanadium steels. The availability of this high grade vanadium oxide in commercial quantities will spur further advances in the use of vanadium as an alloying component. This new oxide is now available in either a dense fused form suitable for direct addition to an alloy furnace, or in granular form from the Alloys Division of Union Carbide Limited, 103 Mount Street, London, W.1.

Turkish Copper Plant

It is reported from Ankara that machinery and equipment for an electrolytic copper refinery have now arrived in Turkey and it is expected that the plant—with a capacity of between 4,000 and 5,000 tons—will be ready to go into operation by the end of 1958. At present, Turkish copper ore from the Ergani and Murgul mines is shipped for processing mainly to foreign countries, including West Germany.

A Birmingham Meeting

One of the first meetings of the professional societies in the New Year will be that of the **Birmingham Metallurgical Society,** on Thursday next, January 9, at 6.30 p.m., in the Byng Kenrick Suite of

the College of Technology, Gosta Green, Birmingham. On this occasion Dr. N. Swindells, M.A., F.I.M., will read a paper on "The Production of Rod and Shapes in Copper and its Alloys." The chair will be taken by Mr. H. W. G. Hignett.

Aluminium in India

Tentative proposals for the setting up of an aluminium plant at Mettur in Madras State have been received from a French company, according to the Indian Minister for Industry, Mr. Manubhai Shah. The firm had offered broad terms of deferred payment, he said.

Aluminium in Norway

According to a report published in Oslo, the Norwegian aluminium industry has been operating almost at capacity this year, and production for the whole of 1957 is expected to total some 95,000 tons. By 1961, the country's annual output capacity for this metal will stand at some 185,000 tons, following the expansion of existing plants and the bringing into production of new ones.

By the end of the year, work will have been completed on the first part of the new plant which AS Elektrokemisk is building at Mosjoen, north Norway, thus adding about 25,000 tons to the country's annual output capacity. In addition, the State-owned aluminium smelter AS Ardal and Sunndal Verk is carrying out an expansion programme which will bring the capacity of that plant to 115,000 tons annually by 1960/1. Norway's two other aluminium producers, Det Norske Nitrid AS and AS Norsk Aluminium also have expansion schemes under way.

Birlec in Canada

Back in Britain after three months in Canada studying trade conditions and future prospects, is Mr. K. J. Palmer, of **Birlec Limited.** An office of the company has already been established in Toronto under the supervision of Mr. Palmer, whose present position with Birlec is that of London Office Manager. Depending on the outcome of Mr. Palmer's visit, there is a possibility that the Birmingham firm will not only sell in Canada, but may also manufacture furnaces there.

Until recently, we understand, Birlec has been prevented from tendering in Canada by the terms of licensing agreements with other companies. Now, however, with those agreements newly revised, Birlec is able to sell directly to Canada. Canada's furnace requirements, both for melting and heat treatment of metals, are growing rapidly, particularly as she is now ranked number four among the trading nations of the world, with every indication that even that position will soon be bettered.

Trade with Bolivia

Discussions have been taking place for some months with the Bolivian Government about the commercial debts owed by that Government and its various agencies, principally the Corporacion Minera de Bolivia, to United Kingdom creditors. It is expected that a firm offer for the settlement of these debts will be made very shortly.

The Board of Trade request any creditors not covered by the Export Credits Guarantee Department to get in touch with the Board's Commercial Relations and Exports Department, Horse Guards Avenue, London, S.W.1, as soon as possible.

Correspondence

Correspondence is invited on any subject considered to be of interest to the non-ferrous metal industry. The Editor accepts no responsibility either for statements made or opinions expressed by correspondents in these columns

L.E.B. Scrap Cable Disposals

TO THE EDITOR OF METAL INDUSTRY

SIR,—Arising from the publicity which has been given to this matter, the Council of my Association, at a meeting which was held on Tuesday, December 10, 1957, decided to send a letter setting out the considered views of the Council to the Trade Press and, at the same time, to send a copy of the letter to the chairman of the London Electricity Board and to the Minister of Power.

The object of my Association is to do all that is possible to be done to redress the position, which they firmly believe to be contrary to the public interest and to the interests of its members as a whole.

Prior to the coming into being of the L.E.B., scrap cable and other scrap metals were disposed of by the various undertakings then operating, by means of accumulating quantities and offering them by tender to those members of the scrap trade who were interested in the purchase of such goods. Tenderers had the opportunity to inspect the goods for which they were asked to quote, with the result that the undertakings received proper competitive offers. When the L.E.B. took over, the method described was changed to one by which the very large tonnages arising were sold for a year ahead at a fixed price, irrespective of the quality of the goods that might arise during the period; the fixed price being only subject to adjustment to cover variations up or down in the market price of copper and lead. It may be that those responsible for these disposals at the L.E.B. are not aware that the values of the scrap cables vary very considerably, according to the copper and lead contents of the many types, which arise in varying proportions. If they were aware of that great variation, it would be difficult to see how they could justify adopting such an unusual method of procedure as regards disposals, which, to the best of our knowledge, is not adopted by any other public undertaking.

Statements have been made to the effect that storage difficulties and danger of pilferage make it essential for these valuable goods to be turned over with all speed; this is not understood. The separate undertakings, existing before the L.E.B., did not experience those difficulties and they disposed of very large tonnages from time to time. Each of the undertakings had storage places in which the goods were kept until sufficient had accumulated, and it is reasonable to assume that those same storage places still exist—in fact, it would be reasonable to assume that reorganization has resulted in better facilities than before. As a rule, the undertakings as they were, sold only a few times during each year. It has been suggested that, when the L.E.B. took over, larger than usual quantities of scrap became available; if that were so, it remained only for disposals to be more frequent. The Post Office and the London Transport Executive, to mention only two of the public undertakings, sell very large quantities of scrap cables, as well as other scrap metals, and they sell as occasion demands, by the normal method of inviting a large number of contractors to tender; if they want the goods promptly collected, they ask for the tenders to be returned within a few days and for the goods to be collected within a stated period.

The issue is clear: the present method of disposals by the L.E.B., in the opinion of my Association, is as wrong as it could be, and they are certain that the only proper method is to dispose of the goods by accumulating them in reasonable quantities and inviting tenders from those interested in the purchase of the goods, who can then inspect the material for which they are bidding. If the L.E.B. are still not convinced of the justification for our complaint, we would strongly urge that the whole matter be referred to an independent committee of investigation.

Yours, etc.,

A. F. Dougall,
Secretary.
National Association of Non-Ferrous Scrap Metal Merchants.

Forthcoming Meetings

January 7—Institute of British Foundrymen. Slough Section. Lecture Theatre, High Duty Alloys Limited, Slough. "Pressure Die-Casting." H. J. Sharp, 7.30 p.m.

January 7—Institute of Metals. Oxford Local Section. Cadena Cafe, Cornmarket Street, Oxford. "Seeing Dislocations." Junior Members' Evening, 7 p.m.

January 7—East Midlands Metallurgical Society. Nottingham and District Technical College, Shakespeare Street, Nottingham. "The Oil Industry." J. Collins. 7.30 p.m.

January 7—Institute of Metal Finishing. Midland Branch. James Watt Memorial Institute, Great Charles Street Birmingham, 3. "Effluent Problems." F. Wild. 6.30 p.m.

January 8—Institute of Metal Finishing. Organic Finishing Group. Royal Society of Tropical Medicine and Hygiene, 26, Portland Place, London, W.1. "Fire Hazards in Organic Finishing and Their Avoidance." L. A. Smith. 6.30 p.m.

January 9—Institute of Metals. Birmingham Local Section. College of Technology, Gosta Green, Birmingham, 4. "The Production of Rod and Shapes in Copper and its Alloys." N. Swindells. 6.30 p.m.

January 9 — Leeds Metallurgical Society. Lecture Room "C", Chemistry Wing, The University, Leeds, 2. "Corrosion Problems and Water Treatment in Power Stations." R. W. Wolforth. 7.15 p.m.

January 9 — Institute of British Foundrymen. Bedfordshire and Hertfordshire Section. K. & L. Steelfounders and Engineers Limited, Letchworth. "Aids to Automation." J. A. Hufton. 7.30 p.m.

Metal Market News

LAST week was inevitably very quiet on account of the intervention of the Christmas holidays and business this week too has been restricted since our market and many overseas centres were shut down on January 1. Prices were reasonably steady at the year end and on the Stock Exchange similar conditions obtained. Wall Street staged a rally, but the outlook is not very rosy and it looks very much as though we may see further liquidation during this first month of the New Year. In copper last week there was a turnover of about 3,550 tons and before Christmas cash fell below £180, but rallied on Friday last to close at £180 10s. cash and £184 three months. This meant losses of 15s. and £1 10s. 0d. for the respective positions and the contango rather surprisingly narrowed to £3 10s. 0d. At the beginning of the week stocks had shown a substantial increase of 775 tons to 19,903 tons so that it is unlikely the contango will remain below £4. In New York price changes were slight, only the Comex quotations varying pretty well in line with London from day to day. Business was not very brisk. There is every indication that when the totals for 1957 are finally available it will be found that consumption of copper in this country is fully up to the previous year's level and possibly above it. In the States, however, the situation is likely to be rather different for, as will be seen from the figures given below, deliveries in November showed a drop compared with the previous month.

Trading in tin last week displayed no special features, but the tone was quietly firm, for a gain of 10s. 0d. was registered in cash and of £1 in three months. It would appear that the Pool is still supporting the market and presumably this will continue, for the present at any rate. Both zinc and lead lost some of the ground they had previously gained and the outlook does not appear to be very bright for these two metals. Lead closed at £73 7s. 6d. prompt and forward which was 17s. 6d. below the previous Friday, while zinc lost 30s. both positions, leaving December at £61 15s. 0d., and March at £62. Tin stocks are still rising and at the beginning of the week were reported 800 tons up at 11,612 tons, the highest level reached for a long time past. Much of this tonnage must obviously be warehoused for account of the Tin Council whose support policy has held the market at £730 for so long. On the secondary metal side there is nothing fresh to report for supplies of both copper and brass are scarce and prices relatively high.

Statistics issued by the Copper Institute for November are shown as follows in terms of short tons of 2,000 lb. Inside the U.S.A. production of crude copper was 97,300 tons, a drop of 4,800 tons on October, while the output of refined was 1,500 tons lower at 128,400 tons. Deliveries of refined copper to consumers at 106,800 tons compared with 114,200 tons in the previous month. Stocks of refined copper were up by nearly 5,000 tons. Outside the United States output of crude copper was up by fully 2,600 tons to 165,000 tons, but refined production dropped by about 7,200 tons to just under 130,000 tons. Deliveries of refined copper showed a spectacular increase of 16,600 tons to 148,700 tons so that one way and another these figures were very good. In total, refined production and deliveries of refined copper were pretty well in balance, which suggests that the cuts in production which have been made are beginning to have their effect.

Birmingham

The New Year opens on an optimistic note in the metal consuming industries in the Birmingham area. During the last twelve months there has been a marked drop in unemployment and short time working. The number of unfilled jobs has risen in that time from 20,000 to 23,000. Much of the present prosperity is due to the recovery in the motor trade. Export business generally has increased, not only in the motor trade but in many others. Some firms not previously interested in the export side are investigating the possibilities. It is also significant of the confidence of industrialists that the Board of Trade reports an increase in the approvals given to firms for new factories and extensions to existing works.

The steel industry maintains a high rate of output though some anxiety has been expressed in regard to the future position of mills rolling structural steel. It is felt that cuts in capital expenditure must slow down the demand for this class of material. Engineering industries are fully employed and there is a big demand for heavy forgings and pressings. Steel is wanted for rolling stock building and maintenance work in fulfilment of orders from British Railways under their modernization plans. Makers of heavy electrical plant have good order books for the next twelve months. Output of steel for 1957 will not, it is believed, achieve its original target due to some curtailment early in the year.

New York

Non-ferrous metals were featureless over the past week. Copper was steady while tin softened. Lead and zinc were unchanged. In copper custom smelters sold modest amounts of electrolytic at 25½ cents per lb. Producers were selling routine quantities at 27 cents per lb. End-of-the-year inventory considerations were restricting the volume of copper sold, traders said. Although recent production cuts had improved the statistical position of copper, traders said further cuts were necessary before price stability could be established. Lead and zinc activity was mixed. One leading seller of zinc said some automotive producers were deferring their January deliveries of special high grade zinc to February because of lagging auto production. Some large users of prime western zinc came in during the week for moderate quantities. Lead sales were spotty. Tin eased off earlier influenced by paring of the London price. Medium sized consumers and dealers bought moderate amounts of tin latterly as the market steadied.

The Aluminium Association reports that primary aluminium production in the United States increased for the second month running in November, but was substantially below the same month last year. November primary production in the United States amounted to 135,024 tons compared with 133,759 in October, and with 145,081 in November, 1956. Total aluminium production for the year through and including November was estimated at 1,507,677 tons.

Zurich

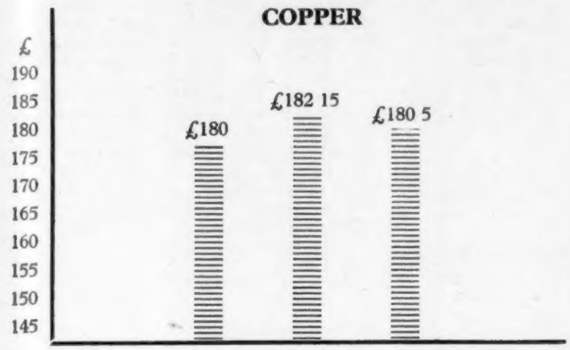
Weak international market trends and the seasonal decline in buying interest made for very quiet conditions in the Swiss non-ferrous metal market during the past few weeks. Lead and copper buying declined while purchases of zinc improved somewhat. Tin consumers came into the market to replenish their stocks. Following the increase in offerings, the "grey market" price for nickel almost disappeared.

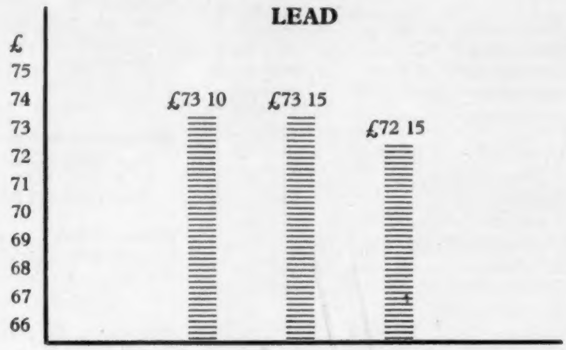
Japan

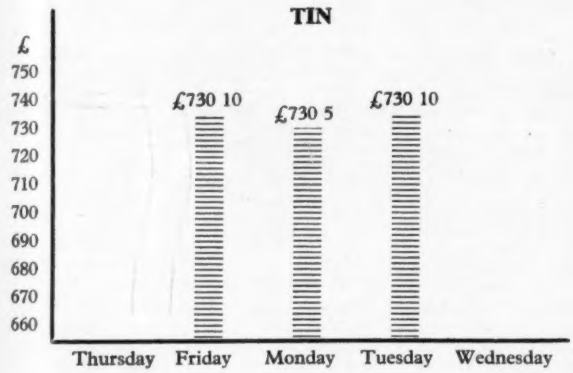
The Japan Light Metals Association reports that output of primary aluminium in October hit a post-war high, partly owing to the abundant supply of electricity. Deliveries of primary metal in October increased slightly compared with September, but were considerably smaller than in October, 1956. Some 20 metric tons of primary aluminium were shipped to Hong Kong in October for the first time in a year during which not a ton was shipped from Japan. A spokesman of the Association said there was hope that more primary aluminium might be exported hereafter. Brisk demand for aluminium on the domestic market was the reason for the absence of export shipments.

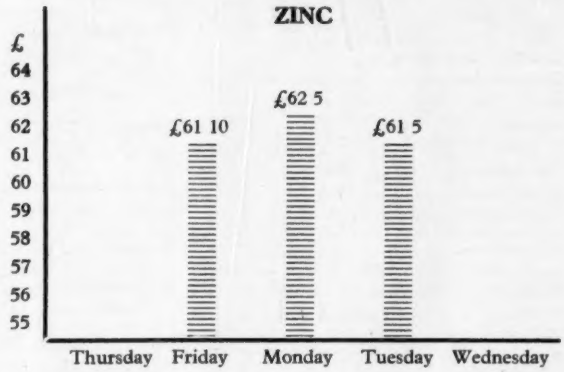
METAL PRICE CHANGES

LONDON METAL EXCHANGE, Friday 27 December 1957 to Wednesday 1 January 1958









OVERSEAS PRICES

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg	≏ £/ton	Canada c/lb	≏ £/ton	France fr/kg	≏ £/ton	Italy lire/kg	≏ £/ton	Switzerland fr/kg	≏ £/ton	United States c/lb	≏ £/ton
Aluminium			24.63	203 10	198	172 5 0	400	232 0	2.50	209 0	28.10	224 17 6
Antimony 99.0					195	169 12 6	440	255 5			33.00	264 0
Cadmium					1,400	1,218 0	2,800	1,624 0			155.00	1,240 0
Copper												
Crude												
Wire bars 99.9							370	214 12 6				
Electrolytic	25.25	184 10	26.50	218 17 6	230	200 2 6			2.25	188 2 6	27.00	216 0
Lead			12.25	101 2 6	123	107 0	185	107 7 6	.92	77 0	13.00	104 0
Magnesium												
Nickel			69.00	570 0	1,060	922 5	1,330	771 10 0	8.10	677 2 6	74.00	592 0
Tin	100.75	736 10			883	768 5	1,400	812 0	9.00	752 6	92.62	741 0
Zinc												
Prime western			10.00	82 12 6							10.00	80 0
High grade 99.95			10.60	87 10 0								
High grade 99.99			11.00	90 5								
Thermic					107.12	93 2 6						
Electrolytic					115.12	100 2 6	157	91 0	.87	72 15	11.75	94 0

NON-FERROUS METAL PRICES

(All prices quoted are those available at 12 noon 1/1/58)

PRIMARY METALS

		£	s.	d.
Aluminium Ingots	ton	197	0	0
Antimony 99·6%	„	197	0	0
Antimony Metal 99%	„	190	0	0
Antimony Oxide	„	180	0	0
Antimony Sulphide Lump	„	190	0	0
Antimony Sulphide Black Powder	„	205	0	0
Arsenic	„	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	„		11	3
Calcium	„	2	0	0
Cerium 99%	„	13	18	0
Chromium	„		6	11
Cobalt	„		16	0
Columbite per unit			—	
Copper H.C. Electro.	ton	180	5	0
Fire Refined 99·70%	„	179	0	0
Fire Refined 99·50%	„	178	0	0
Copper Sulphate	„	71	0	0
Germanium	grm.		3	4
Gold	oz.	12	9	3
Indium	„		10	0
Iridium	„	27	0	0
Lanthanum	grm.		15	0
Lead English	ton	72	15	0
Magnesium Ingots	lb.		2	5½
Notched Bar	„		2	10½
Powder Grade 4	„		6	3
Alloy Ingot, A8 or AZ91	„		2	8
Manganese Metal	ton	300	0	0
Mercury	flask	69	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	„		5	6
Osmium	oz.		nom.	
Osmiridium	„		nom	
Palladium	„	8	0	0
Platinum	„	28	10	0
Rhodium	„	40	0	0
Ruthenium	„	16	0	0
Selenium	lb.		nom.	
Silicon 98%	ton		nom.	
Silver Spot Bars	oz.		6	5⅛
Tellurium	lb.		15	0
Tin	ton	730	10	0
Titanium	lb.		19	6
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	61	5	0
Dust 95/97%	„	107	0	0
Dust 98/99%	„	113	0	0
Granulated 99+%	„		—	
Granulated 99·99+%	„		—	

**Duty and Carriage to customers' works for buyers' account.*

INGOT METALS

		£	s.	d.
†Aluminium Alloy				
B.S. 1490 L.M.[illegible]	ton	154	10	0
B.S. 1490 L.M.[illegible]	„	158	10	0
B.S. 1490 L.M.4	„	182	0	0
B.S. 1490 L.M.6	„	204	10	0

†Average selling prices for November.

		£	s.	d.
***Aluminium Bronze**				
BSS 1400 AB.1	ton	215	0	0
BSS 1400 AB.2	„		—	
***Brass**				
BSS 1400-B3 65/35	„	136	0	0
BSS 249	„		—	
BSS 1400-B6 85/15	„		—	

		£	s.	d.
***Gunmetal**				
R.C.H. 3/4% ton	ton		—	
(85/5/5/5)	„	167	0	0
(86/7/5/2)	„	178	0	0
(88/10/2/1)	„	224	0	0
(88/10/2/½)	„	231	0	0
Manganese Bronze				
BSS 1400 HTB1	„	180	0	0
BSS 1400 HTB2	„	193	0	0
BSS 1400 HTB3	„		—	
Nickel Silver				
Casting Quality 12%	„		nom.	
„ „ 16%	„		nom.	
„ „ 18%	„		nom.	
***Phosphor Bronze**				
2B8 guaranteed A.I.D. released	„		—	
Phosphor Copper				
10%	„	218	0	0
15%	„	225	0	0

**Average prices for the last week-end.*

		£	s.	d.
Phosphor Tin				
5%	ton		—	
Silicon Bronze				
BSS 1400-SB1	„		—	
Solder, soft, BSS 219				
Grade C Tinmans	„	345	9	0
Grade D Plumbers	„	280	0	0
Grade M	„	378	6	0
Solder, Brazing, BSS 1845				
Type 8 (Granulated)	lb.		—	
Type 9 „	„		—	
Zinc Alloys				
Mazak III	ton	95	17	6
Mazak V	„	99	17	6
Kayem	„	105	17	6
Kayem II	„	111	17	6
Sodium-Zinc	lb.		2	5

SEMI-FABRICATED PRODUCTS

Prices of all semi-fabricated products vary according to dimensions and quantities. The following are the basis prices for certain specific products.

		£	s.	d.
Aluminium				
Sheet 10 S.W.G.	lb.		2	9
Sheet 18 S.W.G.	„		2	11
Sheet 24 S.W.G.	„		3	2
Strip 10 S.W.G.	„		2	9
Strip 18 S.W.G.	„		2	10
Strip 24 S.W.G.	„		2	11½
Circles 22 S.W.G.	„		3	3
Circles 18 S.W.G.	„		3	2
Circles 12 S.W.G.	„		3	1
Plate as rolled	„		2	8½
Sections	„		3	2½
Wire 10 S.W.G.	„		3	0
Tubes 1 in. o.d. 16 S.W.G.	„		4	1
Aluminium Alloys				
BS1470. HS10W.				
Sheet 10 S.W.G.	„		3	1½
Sheet 18 S.W.G.	„		3	4
Sheet 24 S.W.G.	„		3	11½
Strip 10 S.W.G.	„		3	1½
Strip 18 S.W.G.	„		3	3
Strip 24 S.W.G.	„		3	11
BS1477 HP30M.				
Plate as rolled			2	11½
Aluminium Alloys—*cont.*				
BS1470. HC15WP.				
Sheet 10 S.W.G.	lb.		3	9½
Sheet 18 S.W.G.	„		4	1½
Sheet 24 S.W.G.	„		4	11½
Strip 10 S.W.G.	„		3	10½
Strip 18 S.W.G.	„		4	1½
Strip 24 S.W.G.	„		4	9
BS1477. HPC15WP.				
Plate heat treated	„		3	6½
BS1475. HG10W.				
Wire 10 S.W.G.	„		3	10½
BS1471. HT10WP				
Tubes 1 in. o.d. 16 S.W.G.	„		5	0
BS1476. HE10WP.				
Sections	„		3	2
Beryllium Copper				
Strip	„	1	4	11
Rod	„	1	1	6
Wire	„	1	4	9
Brass Tubes	„		1	5⅜
Brazed Tubes	„		—	
Drawn Strip Sections	„		—	
Sheet	ton		—	
Strip	„	209	5	0
Extruded Bar	lb.		1	8¾
Extruded Bar (Pure Metal Basis)	„		—	
Condenser Plate (Yellow Metal)	ton	147	0	0
Condenser Plate (Naval Brass)	„	158	0	0
Wire	lb.		2	3
Bronze Sheet and Strip	ton		—	
Copper Tubes	lb.		1	8⅞
Sheet	ton	209	5	0
Strip	„	209	5	0
Plain Plates	„		—	
Locomotive Rods	„		—	
H.C. Wire	„	229	15	0
Cupro Nickel				
Tubes 70/30	lb.		3	2⅜
Lead Pipes (London)	ton	115	5	0
Sheets (London)	„	113	0	0
Tellurium Lead	„		£6 extra	
Nickel Silver				
Rods	lb.		—	
Sheet and Strip 7%	„		3	3½
Wire 10%	„		3	10
Phosphor Bronze				
Wire	„		3	6½
Titanium				
Billet	lb.	4	10	0
Sheet	„	6	12	0
Wire	„	9	10	0
Tube	„	16	0	0
Zinc Sheets, English destinations	ton	95	10	0
Strip	„		nom.	

LATE NEWS

London.—Stocks of refined tin in London Metal Exchange warehouses at the end of last week totalled 12,182 tons, comprising London 4,130 tons, Liverpool 7,302 and Hull 750 tons. Copper stocks totalled 20,304 tons and comprised London 11,121 tons, Liverpool 6,658, Birmingham 1,650, Manchester 25, Swansea 600 and Hull 250 tons.

Scrap Metal Prices

Merchants' average buying prices delivered, per ton, 31/12/57.

	£
Aluminium	
New Cuttings	158
Old Rolled	130
Segregated Turnings	95
Brass	
Cuttings	125
Rod Ends	113
Heavy Yellow	93
Light	88
Rolled	115
Collected Scrap	90
Turnings	109
Copper	
Wire	157
Firebox, cut up	157
Heavy	150
Light	145
Cuttings	157
Turnings	141
Braziery	125

	£
Gunmetal	
Gear Wheels	157
Admiralty	157
Commercial	128
Turnings	123
Lead	
Scrap	64
Nickel	
Cuttings	—
Anodes	550
Phosphor Bronze	
Scrap	128
Turnings	123
Zinc	
Remelted	53
Cuttings	44
Old Zinc	29

The latest available scrap prices quoted on foreign markets are as follow. (The figures in brackets give the English equivalents in £1 per ton.) :—

West Germany (D-marks per 100 kilos):		
Used copper wire	(£161.0.0)	185
Heavy copper	(£156.12.6)	180
Light copper	(£134.17.6)	155
Heavy brass	(£100.0.0)	115
Light brass	(£74.0.0)	85
Soft lead scrap	(£56.10.0)	65
Zinc scrap	(£39.2.6)	45
Used aluminium unsorted	(£87.0.0)	100
France (francs per kilo):		
Copper	(£213.2.6)	245
Heavy brass	(£182.15.0)	210
Light brass	(£152.5.0)	175
Zinc castings	(£67.17.6)	78
Tin	(£565.10.0)	650
Aluminium pans (98½ per cent)	(£139.5.0)	160

Italy (lire per kilo):		
Aluminium soft sheet clippings (new)	(£194.7.6)	335
Aluminium copper alloy	(£104.10.0)	180
Lead, soft, first quality	(£90.0.0)	155
Lead, battery plates	(£53.7.6)	92
Copper, first grade	(£174.0.0)	300
Copper, second grade	(£159.10.0)	275
Bronze, first quality machinery	(£179.17.6)	310
Bronze, commercial gunmetal	(£150.17.6)	260
Brass, heavy	(£119.0.0)	205
Brass, light	(£110.5.0)	190
Brass, bar turnings	(£124.15.0)	215
New zinc sheet clippings	(£58.0.0)	100
Old zinc	(£43.10.0)	75

Financial News

New Companies

The particulars of companies recently registered are quoted from the daily register compiled by Jordan and Sons, Limited, Company Registration Agents, Chancery Lane, W.C.2.

J. E. Johnson (Platers) Limited (592771), 74 Church Gate, Leicester. Registered October 30, 1957. To take over business of electro-platers and metal finishers carried on at Leicester as "J. E. Johnson and Co.," etc. Nominal capital, £10,000 in £1 shares. Directors: A. R. Barker and N. W. Tudor.

Flame Heating Limited (592970), 12 Bow Lane, E.C.4. Registered November 1, 1957. To carry on business of designers and manufacturers for the purposes of sale of equipment, plant and machinery for the heat-treatment of metals, etc. Nominal capital, £2,000 in £1 shares. Directors: T. L. Leach, A. P. Howard and W. B. Kemmish.

Metrax Converters Limited (593000), Armoury Works, Wright Street, Small Heath, Birmingham, 10. Registered November 4, 1957. To carry on business of manufacturers of and dealers in scrap metals and other waste and raw material, etc. Nominal capital, £1,000 in £1 shares. Directors: M. Ramsey, M. Starr and J. G. Jobes.

Chester Metal Co. Limited (593056), Saughall Nurseries, Parkgate Road, Saughall, near Chester. Registered November 5, 1957. To carry on business of electroplaters, engineers, etc. Nominal capital, £500 in £1 shares. Directors: M. R. Spall, Mrs. F. Hitchcock and T. F. Stannett.

Ducatal Limited (593127), 18 Half Moon Street, W.1. Registered November 6, 1957. To use the "Ducatal System" and other methods of joining metal sheets, etc. Nominal capital, £1,100 in 1,000 cum. pref. shares of £1 and 2,000 ord. shares of 1s. each. Directors: M. Burzi and C. E. W. C. Mackintosh.

Material Recoveries (London) Limited (593316), 198 Marton Road, Middlesbrough. Registered November 8, 1957. To carry on business of merchants of and dealers in waste and scrap materials, etc. Nominal capital, £2,000 in £1 shares. Directors: J. I. Baum and Sarah Baum.

J. J. Moore (West Vale) Limited (593553), Maude Street, West Vale, near Halifax. Registered November 13, 1957. To carry on business of bronze, brass, iron and ferrous and non-ferrous metal founders, etc. Nominal capital, £4,000 in £1 shares. Permanent directors: J. J. G. Moore, Connie Moore and R. Moore.

Protodraft Limited (593687), Nation House, Hampton Road, Teddington. Registered November 14, 1957. To carry on business of designers, manufacturers and distributors of scientific, electrical, mechanical, constructional and precision instruments, etc. Nominal capital, £100 in £1 shares. Directors to be appointed by subscribers.

Metals Research Limited (593774), 91 King Street, Cambridge. Registered November 15, 1957. Nominal capital, £15,000 in £1 shares (10,000 Ord. and 5,000 "A" Ord.). Directors: Dr. M. Cole, J. Moores and T. P. Hoar.

Metalwork (Hurn) Limited (593775), Bourne Chambers, St. Peter's Road, Bournemouth. Registered November 15, 1957. To carry on business of light engineers, etc. Nominal capital, £6,000 in £1 shares. Directors: F. Belcher and Mrs. I. J. Belcher.

Woodcock and Booth Limited (593800), Woodvale Brass Works, Brighouse, Yorks. Registered November 15, 1957. To carry on business of brassfounders, ironfounders, etc. Nominal capital, £7,500 in £1 shares. Directors: C. E. Woodcock and Mrs. D. Woodcock.

Southern Polishing Company Limited (593898), Balfour House, Finsbury Pavement, E.C.2. Registered November 19, 1957. To carry on business of platers, polishers, general finishers to jewellery trade, etc. Nominal capital £150 in 100 "A" Ordinary shares of £1 and 100 "B" Ordinary shares of 10s. each. Directors: P. G. Denton and N. L. Gibson.

Kemp Precision Tooling Limited (593979), 37 Junction Road, Croydon, Surrey. Registered November 20, 1957. To carry on business of iron masters, founders and workers, manufacturers of and dealers in forgings, castings, tools, etc. Nominal capital, £1,000 in £1 shares. Directors: R. R. R. Kemp, Mrs. O. E. A. Kemp and R. H. Kemp.

Trade Publications

Electrical Precipitators. — W. C. Holmes and Co. Ltd., Turnbridge, Huddersfield.

This 24-page brochure gives details of the Holmes-Elex electrical precipitators, describing the principle and practical aspects as well as the range of electrical equipment for which the company is responsible. Typical applications of electrical precipitation are included, as well as a number of excellent illustrations.

Fire Resistant Fluids. — Mobil Oil Company Ltd., Caxton House, Westminster, London, S.W.1.

A booklet describes the fire resistant water-base hydraulic fluids which this company provides in Mobil Nyvac No. 20 and No. 30. The aim of this booklet is to provide such information as will enable managements to reach a correct decision as to the use of these fluids as well as to provide suggestions concerning proper installation and use procedure.

Aluminium Foil — The Star Aluminium Co. Ltd., 97 Penn Road, Wolverhampton.

A number of interesting notes on this company's activities and its works at Wolverhampton and Bridgnorth are contained in the "Star Foil Review." There are also several excellent illustrations.

THE STOCK EXCHANGE

Prices Moved Uncertainly And Conditions Very Quiet

ISSUED CAPITAL ●	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 31 DECEMBER	+RISE —FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1957 HIGH	1957 LOW	1956 HIGH	1956 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	19/3	+3d.	10	10	10 7 9	28/3	18/-	25/-	20/-
400,000	2/-	Anti-Attrition Metal	1/6		8½	7½	11 6 9	2/6	1/6	2/2½	1/6¾
33,639,483	Stk. (£1)	Associated Electrical Industries ...	48/3	+6d.	15	15	6 4 3	72/3	47/9	85/7½	57/3
1,590,000	1	Birfield Industries	54/-	—1/-	15	20N	5 11 0	70/-	48/9	110/7½	48/9
3,196,667	1	Birmid Industries	57/3	—1/3	17½	17½	6 2 3	80/6	55/9	81/9	58/9
5,630,344	Stk. (£1)	Birmingham Small Arms	26/9	—3d.	10	8	7 9 6	33/-	21/9	39/9	20/-
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	15/-		5	5	6 13 3	16/-	15/-	18/6	14/10½
350,580	Stk. (£1)	Ditto Cum. B. Pref. 6% ...	16/6		6	6	7 5 6	19/-	16/6	21/6	17/9
500,000	1	Bolton (Thos.) & Sons	28/9		12½	12½	8 14 0	30/3	28/9	31/-	29/6
300,000	1	Ditto Pref. 5%	15/3	+3d.	5	5	6 11 3	16/9	14/3	18/1½	15/9
160,000	1	Booth (James) & Co. Cum. Pref. 7%	19/-		7	7	7 7 3	22/3	18/9	23/-	21/6
9,000,000	Stk. (£1)	British Aluminium Co.	41/-		12	12	5 17 0	72/-	38/3	81/10½	40/6
1,500,000	Stk. (£1)	Ditto Pref. 6%	18/3	—6d.	6	6	6 11 6	21/6	18/-	21/10½	19/6
15,000,000	Stk. (£1)	British Insulated Callender's Cables	40/-		12½	12½	6 5 0	55/-	40/-	54/9	45/3
17,047,166	Stk. (£1)	British Oxygen Co. Ltd., Ord. ...	32/-	—3d.	10	15N	6 5 0	39/-	29/6	63/6	32/3
600,000	Stk. (5/-)	Canning (W.) & Co.	20/6		25	25	6 2 0	24/6	19/3	25/6	19/-
60,484	1/-	Carr (Chas.)	2/3		25	25	11 2 3	3/6	2/1½	3/-	2/4½
150,000	2/-	Case (Alfred) & Co. Ltd.	4/6	+3d.	25	25	11 2 3	4/6	4/-	5/-	3/10½
555,000	1	Clifford (Chas.) Ltd.	15/9		10	15N	12 14 0	20/6	15/9	35/-	21/1½
45,000	1	Ditto Cum. Pref. 6%	16/-		6	6	7 10 0	17/6	16/-	19/-	17/9
250,000	2/-	Coley Metals	4/1½	—3d.	25	25	12 2 6	5/7½	3/9	5/1½	3/7½
8,730,596	1	Cons. Zinc Corp.†	49/-	—3d.	22½	22½	9 3 9	92/6	49/-	70/7½	46/3
1,136,233	1	Davy & United	47/-		15	12½	6 7 9	60/6	42/6	50/6	41/3
2,750,000	5/-	Delta Metal	21/-	+3d.	*17½	*17½	4 3 3	28/6	19/-	25/9	18/3
4,160,000	Stk. (£1)	Enfield Rolling Mills Ltd.	26/-	+3d.	15B	22½	9 12 3	38/6	25/-	39/7½	30/-
500,000	1	Evered & Co.	42/-		15	15	7 2 9	52/9	42/-	56/-	52/-
18,000,000	Stk. (£1)	General Electric Co.	38/-	—6d.	14	12½	7 7 3	59/-	38/-	65/6	41/3
1,250,000	Stk. (10/-)	General Refractories Ltd.	27/9	+3d.	17½	17½	6 6 0	37/-	26/9	33/6	24/1½
401,240	1	Gibbons (Dudley) Ltd.	65/-		15	12	4 12 3	71/-	53/-	54/-	50/-
750,000	5/-	Glacier Metal Co. Ltd.	6/-		11½	11½	9 11 9	8/1½	5/10½	8/6	6/3
1,750,000	5/-	Glynwed Tubes	12/10½	—1½d.	20	20	7 15 3	18/-	12/6	18/3	15/9
3,614,032	10/-	Goodlass Wall & Lead Industries ...	29/6	—6d.	18	16	6 2 0	37/3	28/9	34/7½	26/10½
342,195	1	Greenwood & Batley	46/10½		17½	17½	7 9 3	50/-	46/-	48/-	45/-
396,000	5/-	Harrison (B'ham) Ord.	12/4½		*15	*30‡	6 1 3	16/9	12/4½	42/9	14/10½
150,000	1	Ditto Cum. Pref. 7%	18/9		7	7	7 9 3	22/3	18/7½	25/-	22/-
1,075,167	5/-	Heenan Group	7/3	+4½d.	10	20‡	6 18 0	10/4½	6/9	‖8/6	6/6¾
142,045,750	Stk. (£1)	Imperial Chemical Industries ...	38/-	+4½d.	10	10	5 5 3	46/6	36/3	50/-	36/6
33,708,769	Stk. (£1)	Ditto Cum. Pref. 5%	16/1½		5	5	6 4 0	18/6	15/6	19/9	16/3
14,584,025	**	International Nickel	136	+2½	$3.75	$3.75	4 18 9	222	130	210	141¾
430,000	5/-	Jenks (E. P.) Ltd.	15/1½	—3d.	27½	27½	9 4 9	18/10½	15/1½	18/3	15/-
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	15/-		5	5	6 13 3	17/-	14/6	18/-	16/3
3,987,435	1	Ditto Ord.	40/7½	—7½d.	10	9	4 18 6	58/9	40/-	52/-	40/9
600,000	10/-	Keith, Blackman	16/3		15	15	9 4 6	21/9	15/-	25/10½	18/9
160,000	4/-	London Aluminium	3/10½	+4½d.	10	5	10 6 6	6/9	3/6	8/-	5/-
2,400,000	1	London Elec. Wire & Smith's Ord....	41/-		12½	12½	6 2 0	54/6	41/-	52/9	42/6
400,000	1	Ditto Pref.	22/-	—3d.	7½	7½	6 16 3	25/3	21/9	26/-	24/-
765,012	1	McKechnie Brothers Ord.	37/6		15	15	8 0 0	48/9	37/6	58/1½	50/6
1,530,024	1	Ditto A Ord.	36/9	+9d.	15	15	8 3 3	47/6	36/-	58/-	46/9
1,108,268	5/-	Manganese Bronze & Brass	9/4½	+1½d.	27½‡	25	7 6 6	21/10½	7/6	18/9	15/4½
50,628	6/-	Ditto (7½% N.C. Pref.)	5/9		7½	7½	7 16 6	6/6	5/-	6/3	5/6
13,098,855	Stk. (£1)	Metal Box	43/3	+4½d.	20‡	15M	4 12 6	59/-	40/3	54/6	41/6
415,760	Stk. (2/-)	Metal Traders	6/4½		50	50	15 13 9	8/-	6/3	8/-	5/10½
160,000	1	Mint (The) Birmingham	22/6		10	10	8 17 9	25/-	21/6	25/3	22/6
80,000	5	Ditto Pref. 6%	83/6		6	6	7 3 9	90/6	83/6	92/6	84/6
3,064,930	Stk. (£1)	Morgan Crucible A	36/6	—3d.	10	11	5 9 6	54/-	35/-	48/3	38/6
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	17/3	+3d.	5½	5½	6 7 6	19/3	16/-	20/7½	18/-
2,200,000	Stk. (£1)	Murex	58/6		20	20	6 16 9	79/9	57/-	74/-	60/-
468,000	5/-	Ratcliffs (Great Bridge)	7/1½		10	10Y	7 0 3	8/-	6/10½	10/3	7/-
234,960	10/-	Sanderson Bros. & Newbould ...	24/9		27½D	27½	7 8 3	41/-	24/9	38/-	33/-
1,365,000	Stk. (5/-)	Serck Radiators	11/6	—1½d.	17½Z	15	5 1 6	18/10½	11/6	16/3	12/3
600,400	Stk. (£1)	Stone (J.) & Co. (Holdings)	43/9	+3d.	16	16	7 6 6	57/6	43/9	59/6	49/-
600,000	1	Ditto Cum. Pref. 6½%	20/-		6½	6½	6 10 0	21/9	18/9	21/9	20/3
14,494,862	Stk. (£1)	Tube Investments Ord.	52/6	+6d.	15	15	5 14 3	70/9	50/6	70/7½	50/9
41,000,000	Stk. (£1)	Vickers	30/-		10	10	6 13 3	46/-	29/-	44/6	32/4½
750,000	Stk. (£1)	Ditto Pref. 5%	15/6		5	5	6 9 0	18/-	14/-	18/7½	15/3
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	21/6		*5	*5	7 3 6A	24/9	20/7½	25/6	22/6
2,200,000	1	Ward (Thos. W.), Ord.	71/-	—6d.	20	15	5 14 3	83/-	64/-	69/3	58/9
2,666,034	Stk. (£1)	Westinghouse Brake	32/6	+6d.	18P	18	5 10 9	85/-	29/1½	100/6	68/-
225,000	2/-	Wolverhampton Die-Casting ...	7/7½		25	40	6 11 3	10/1½	7/-	14/10½	8/-
591,000	5/-	Wolverhampton Metal	15/-	—4½d.	27½	27½	9 3 3	22/3	14/9	21/10½	16/-
78,465	2/6	Wright, Bindley & Gell	3/9		20	17½E	13 6 9	3/9	2/7½	3/9	2/6
124,140	1	Ditto Cum. Pref. 6%	11/6		6	6	10 8 9	12/6	11/3	14/-	12/4½
150,000	1/-	Zinc Alloy Rust Proof	2/9		40D	33½	9 14 0	5/-	2/9	4/-	2/9

*Dividend paid free of Income Tax. † Incorporating Zinc Corpn. & Imperial Smelting. ** Shares of no Par Value. ‡ and 100% Capitalized issue. ● The figures given relate to the issue quoted in the third column. A Calculated on £7 14 6 gross. H and 200% capitalized issue. M and 10% capitalized issue. Y and 25% capitalized issue. ‖ Adjusted to allow for capitalization issue E for 15 months. P and 100% capitalized issue, also "rights" issue of 2 new shares at 35/- per share or £3 stock held. D and 50% capitalized issue. Z and 50% capitalized issue. B Equivalent to 12½% on existing Ordinary Capital after 100% capitalized issue.

6
4½
9

given
alized
scock